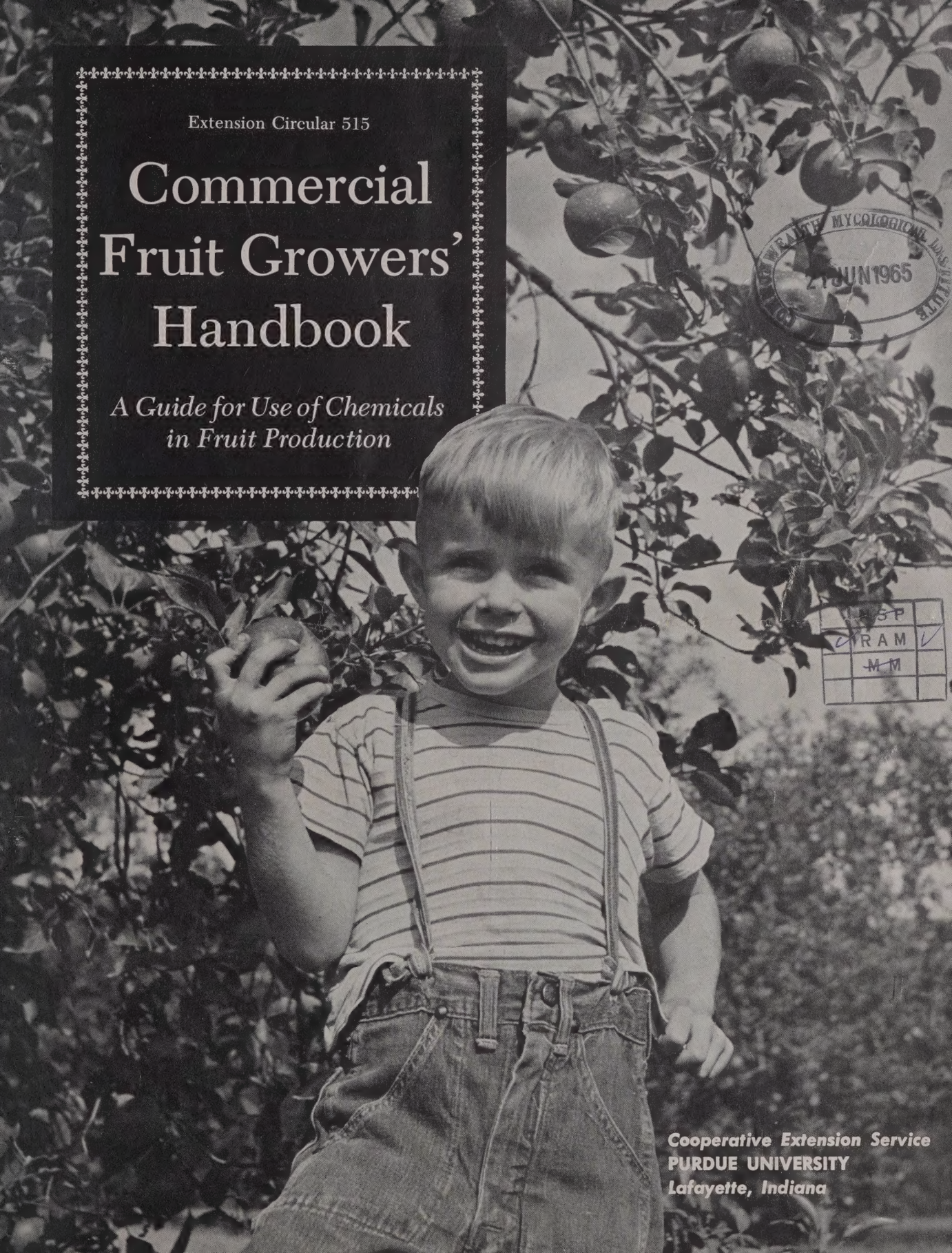

Extension Circular 515

Commercial Fruit Growers' Handbook

A Guide for Use of Chemicals in Fruit Production

Cooperative Extension Service
PURDUE UNIVERSITY
Lafayette, Indiana

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APPLE BUD DEVELOPMENT

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Color plates courtesy E. I. du Pont de Nemours, Wilmington, Delaware.

Commercial Fruit Growers' Handbook

A guide for use of chemicals in fruit production

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This publication deals primarily with identifying and controlling special disease and insect problems of Indiana commercial fruit. Attention is focused on the pest control chemicals—their nature, formulations, toxicities and safe use.

Special problems affecting three of the state's most commercially important fruit crops—apples, peaches and strawberries — are also discussed. These are problems requiring control measures that are less subject to yearly change. Those problems warranting control recommendations that are highly subject to change are presented along with the annual fruit spray guides in Purdue Extension Mimeo ID-60, "Indiana Fruit Spray Schedules."

The spray schedules in Mimeo ID-60 will be revised each year and should be available about January 15 from your County Extension Office or from Agricultural Publications, AES Building, Purdue University, Lafayette, Indiana.

Remember, the publication you now have does *not* replace the spray schedules, but should help complete the fruit insect and disease control picture, so you can more adequately plan and perform your control program.

Fungicides for Fruit Disease Control

The following fungicides are currently recommended for disease control on Indiana fruits. Discussed here are their uses, special application problems, toxicities and common formulations. Their trade names and manufacturers are listed in table 19, beginning on page 26.

The abbreviation WP stands for wettable powder.

The information given herein is supplied with the understanding that no discrimination is intended and no endorsement by the Indiana Cooperative Extension Service is implied.

Captan

Controls apple scab, black rot, fly speck, Brooks' spot, sooty blotch, black pox, bot rot, strawberry leafspot, strawberry harvest rot, grape black rot, raspberry anthracnose and spur blight.

Does *not* control cedar rust and powdery mildew. May cause leaf spotting on Red Delicious, Baldwin or Stayman apples, especially on low vigor or over-loaded trees. *Not* compatible with oil, lime, lime-sulfur or other highly alkaline materials.

Primarily a protectant-type fungicide, but has some eradicant action against apple scab if applied within 24 to 36 hours after infection begins. Believed to be effective in the inactivation of scab spots on foliage to prevent further secondary spread.

For scab, use captan 50% WP at 2 pounds in 100 gallons of water in the primary scab sprays. If scab is under control, reduce to 1 pound in 100 gallons of water in the cover sprays. For grape black rot, raspberry anthracnose and spur blight, use 2 pounds in 100 gallons of water. For strawberry leafspot and strawberry harvest rot, use 6 pounds per acre.

Also available as a 7.5 to 10% Dust combined with insecticides. Use at the rate of 40 pounds per acre. At recommended dosages, captan will safen lead arsenate, so spray lime need not be added.

Copper Fungicides

Control grape downy mildew, black rot and powdery mildew.

Propietary copper fungicides, known as low soluble or fixed coppers, are available as wettable powders and contain 26 to 53 percent copper. To guard against possible fruit or tree injury from soluble copper, add 1 pound of fresh hydrated lime to each ¼ pound of actual metallic copper used in the spray mixture.

Dodine

Controls apple scab, cherry leafspot, strawberry leaf scorch, strawberry leafspot and strawberry leaf blight.

Does *not* adequately control fruit rots and certain summer diseases of apple. Is *not* compatible with chlorobenzilate, genite EC or highly alkaline materials like lime and bordeaux mixture.

For apple scab, apply dodine 65% WP at ¼ to ½ pound in 100 gallons of water OR dodine 3 or 4% Dust at 25 to 40 pounds per acre at 5 to 7-day intervals or as needed to maintain control from pre-bloom through the first cover sprays. In subsequent cover sprays, use dodine 65% WP at ¼ pound in 100 gallons of water as needed. If used after a scab infection period, apply ¾ pound in 100 gallons of water during or following a rain from pre-bloom through first cover spray and in later cover sprays as needed. Use dodine within 36 to 48 hours from the beginning of a rain or wet period, which causes apple scab infection.

While alone not adequate in controlling certain summer apple diseases, dodine 65% WP at ¼ pound *plus* half-strength summer fungicide in 100 gallons of water should give control.

Do not wash dodine WP through filler screen into spray tank. Do *not* apply immediately before, during or immediately after freezing or near freezing temperatures because of possible chemical injury to the fruit. Can be safely used at recommended dosages with most common fungicides, insecticides and acaricides.

Dichlone

Controls apple scab.

May cause fruit russeting if applied after bloom. Is a skin irritant, so avoid skin contact, and follow all label directions. *Not* compatible with bordeaux mixture, oil or lime.

Has scab eradicant action if applied on wet foliage within 40 to 50 hours after infection. May be used alone at ½ pound in 100 gallons of water OR at ¼ pound *plus* half-strength captan or ferbam in 100 gallons of water.

Ferbam

Controls apple scab, Brooks' spot, fly speck, bitter rot, apple rust, grape black rot and peach leaf curl.

Gives poor finish on Golden Delicious, Grimes Golden and other yellow apple varieties. Late season sprays leave objectionable black residue that prevents uniform coloring. Scab control about equal to wettable sulfur.

Use primarily for control of rust diseases at 1½ pounds in 100 gallons of water OR in combination with other scab fungicides at ¾ pound in 100 gallons of water. For grape black rot, use at 2 pounds in 100 gallons of water. For peach leaf curl, use as dormant spray.

Folpet

Controls various diseases of fruits, vegetables and berry crops. In 3 years of trial near Bedford, it has given improved control of summer diseases (bot rot, black rot, sooty blotch, etc.) on Grimes Golden and Golden Delicious apples.

Tolerances for folpet residues have been established at 50 parts per million for apples, avocados, blackberries, boysenberries, cherries, citrus, crabapples, cranberries, currants, dewberries, gooseberries, grapes, huckleberries, loganberries, melons, pumpkins, raspberries and strawberries.

Use as a cover spray at 2 pounds in 100 gallons of water OR combine at half strength with 1 pound of zineb. Is compatible with common fruit insecticides.

Glyodin

Controls apple scab and cherry leafspot.

Has given good finish on all apple varieties except Golden Delicious. On Golden Delicious, do *not* use during pre-pink through second cover spray.

Liquid Lime-sulfur

Controls apple scab, apple mildew and raspberry anthracnose.

Both a protectant and an eradicant for scab. Tends to burn and dwarf apple foliage.

Still an inexpensive and highly effective scab fungicide when used in the early pre-bloom sprays. For raspberry anthracnose, use at 10 gallons in 100 gallons of water applied in the delayed dormant stage.

Niacide

Controls apple scab and summer apple diseases.

Gives excellent fruit finish on both red and yellow varieties. For scab, use at 2 pounds in 100 gallons of water through the primary scab season and at 1 pound in 100 gallons of water in the cover sprays.

Organic Mercuries

Control apple scab and strawberry leafspot.

Eradicates or "burns out" scab after infections have taken place. Full strength (1 pint of 5 percent in 100 gallons of water) will burn out scab

up to 75 or more hours after infection. Half strength together with half-strength sulfur, ferbam or captan will burn out scab up to 50 hours after infection. Do *not* use after first cover spray.

Use full strength only as an emergency because of danger of leaf injury and reduced fruit set. Use half-strength applications immediately after infection periods if doubtful about the effectiveness of the protectant fungicide coverage when infection began. Do *not* carry liquid forms over from the previous year. Methyl mercuries appear less harmful to fruit set when used in bloom and petal-fall sprays.

For strawberry leafspot, apply organic mercuries in the fall at manufacturer's directions.

Sulfur

Controls apple scab and apple mildew.

Causes foliage burning and fruit russeting if used during hot weather (85°+). Wettable powders and sulfur pastes for scab cause less foliage injury than liquid lime-sulfur, especially under slow drying conditions. For apple mildew, use in pre-bloom sprays.

Thiram

Controls strawberry leafspot, strawberry harvest rot, peach brown rot and apple scab (protectant only). Will not eradicate established scab infections.

For strawberry leafspot and harvest rot, use thiram 65% WP at 6 pounds in 100 gallons of water, making at least four applications. For peach brown rot, use thiram 65% WP at 2 pounds in 100 gallons of water as a summer fungicide. For apple scab, use thiram 65% WP at 2 pounds in 100 gallons of water.

Zineb

Controls summer apple diseases, sooty blotch and flyspeck.

For summer diseases, use zineb 75% WP at 1 pound in 100 gallons of water combined with other organic fungicides at half strength throughout the cover sprays.

Insecticides for Fruit Insect and Mite Control

The following insecticides and miticides are currently recommended for Indiana. Presented here are their uses, toxicities and common formulations. Their trade names and manufacturers are listed in table 19, beginning on page 26.

The abbreviation EC stands for emulsifiable concentrate and WP for wettable powder.

PHOSPHATE INSECTICIDES AND MITICIDES

Demeton

Controls aphids and mites on fruit.

Highly toxic to humans. Applicator must wear an approved respirator and protective clothing. Follow all label precautions.

Demeton is a systemic cleared for use on apples, pears, peaches, plums, cherries, strawberries and grapes. Do *not* apply more than three times during growing season or within 21 days of harvest. Do *not* use more than ½ pint in 100 gallons of water on pears. Common formulation is 2 pounds per gallon EC.

Diazinon

Controls codling moth, aphids, mites and apple maggot, scale insects, fruit tree leaf roller, pear psylla, some caterpillars and strawberry leaf roller.

Moderately toxic to humans—intermediate between malathion and parathion. Common formulations are 50% WP and 4 pounds per gallon EC.

EPN

Controls codling moth, plum curculio, mites, oriental fruit moth, peach tree borer, lesser peach tree borer and scales.

Highly toxic to humans. Follow label precautions for safe handling. Common formulations are 25% WP and 1 to 3% Dust.

Ethion

Controls rosy apple aphid, mites and scale insects on apples, peaches, cherries and pears.

Common formulations are 25% WP and a combination Ethion-miscible oil.

Guthion

Controls aphids, mites (if used in consecutive applications), scale insects, codling moth, redbanded leaf roller, plum curculio, peach tree borer, oriental fruit moth and stink bugs.

May cause russeting on pears. Highly toxic to humans if taken orally. Moderately toxic if spilled on the skin. Follow label precautions for safe use and handling. Common formulations are 25% WP and 2 pounds per gallon EC.

Malathion

Controls aphids, bagworm, leafhoppers, mites, scale insects, some caterpillars, pear psylla, lesser peach tree borer and fruit flies.

Moderately low toxicity to humans. In some orchards, mites have developed a high degree of resistance. Common formulations are 5 and 8

pounds per gallon EC, 25% WP and 4 or 5% Dust. Use only 25% WP on cherries.

Parathion

Controls aphids, lesser peach tree borer, peach tree borer, leafhoppers, leaf miners, red-banded leaf roller, scale insects, codling moth, oriental fruit moth and mites.

Highly toxic to humans. Applicator must wear protective clothing and an approved respirator. Always follow label precautions. In some orchards, mites have developed a high degree of resistance. Common formulations are 2 or 8 pounds per gallon EC, 15 or 25% WP and 1 or 2% Dust.

Phosdrin

Controls red-banded leaf roller if used in late season, and other insects that the regular schedule fails to control if used as a "clean up" material.

Highly toxic to humans. Applicator must wear an approved respirator, goggles and other protective clothing. Common formulations are 2 or 4 pounds per gallon EC and 10% WP.

Phosphamidon

Controls aphids, codling moth and mites on apples.

Follow label precautions for safe use and handling. A systemic commonly available as a 4 pounds per gallon EC.

TEPP

Controls aphids and mites.

Highly toxic to humans. May injure cherries, pears and apples. Applicator must wear an approved respirator and proper protective clothing. Common formulations are 20 to 40% EC and 2 to 5% Dust.

Trithion

Controls mites if used at mid-season.

Highly toxic to humans. Applicator must wear an approved respirator and proper protective clothing. Do *not* apply before the third cover. Common formulations are 4 pounds per gallon EC and 25% WP.

NON-PHOSPHATE INSECTICIDES AND MITICIDES

Aldrin

Controls grasshoppers and soil insects; also white grubs, root aphids and crown borer in strawberries.

Moderately high toxicity to humans. Common formulations are 2 or 4 pounds per gallon EC, 50% WP and 2.5 to 25% Granules.

BHC (benezene hexachloride)

Controls aphids.

Has a disagreeable odor that may cause off-flavor in food crops. Moderately toxic to humans. Apply in the pink sprays. Purified form called lindane. Common formulations are 1 or 2 pounds per gallon EC and 10 to 36% WP.

Chlordane

Controls white grubs, root aphids and crown borer.

Moderately toxic to humans. Common formulations are 4 to 8 pounds per gallon EC, 40% WP and 5 to 10% Dusts and Granules.

Chlorbenside

Controls mites on fruit trees.

Moderately low toxicity to humans. Apply in pre-bloom sprays. Common formulations are 2 pounds per gallon EC and 40% WP.

Chlorobenzilate

Controls mites on apple, cherry and pear trees.

Low toxicity to humans. Do *not* apply before second cover. Do *not* use on Red Delicious, Jonathan and McIntosh apple varieties. Do *not* use on peaches, and use no more than 1½ pounds in 100 gallons of water on pears. Common formulation is 25% WP.

DDT

Controls flat and round-headed apple tree borers, codling moth, buffalo treehopper, shot hole borers, leafhoppers, scale insects, pear slugs, peach tree borer, rose chafer, tarnished plant bugs, leaf beetles and grape berry moth.

Moderate toxicity to humans. In some areas, codling moth has developed resistance. Common formulations are 2 pounds per gallon EC, 50% WP and 5 to 10% Dusts.

Dieldrin

Controls plum curculio, codling moth, pear psylla, oriental fruit moth, stink bugs, rose chafer and pear slugs.

Moderately high toxicity to humans. Apply according to spray schedule rates. Do *not* use on apricots. Common formulations are 1.5 pounds per gallon EC, 50% WP and 1.5% Dust.

DN (Dinitro) Compounds

Control aphids and scale insects.

Apply as a dormant spray. Some newer materials are replacing dinitro compounds.

Dormant Oils

Controls aphids (if combined with phosphate insecticides at manufacturer's directions), scale insects and mite eggs.

Superior oils (70 vis.) suggested for trial during delayed dormant or pre-pink stage for mites.

Endrin

Controls curculio and red-banded leaf roller.

More toxic to humans than other commonly-used chlorinated hydrocarbons. Must *not* be applied later than petal-fall spray. Common formulation is 75% WP.

Genite

Controls mites.

Apply up to first cover spray. Common formulations are 50% EC and 50% WP.

Kelthane

Controls red and two-spotted mites on fruit trees.

Apply at mid-season. Common formulations are 18.5% WP and 18.5% EC.

Lead Arsenate

Controls apple leaf skeletonizer, apple maggot, bagworm, round and flat-headed apple tree borers, cankerworm, codling moth, eastern tent caterpillar, fall webworm, green fruitworm, red-banded leaf roller, plum curculio, yellow-necked caterpillar and pear slug.

May injure peaches. Highly toxic to humans if swallowed. Repeated applications must be safened with equal parts of lime or other safeners to prevent plant injury (see "Safeners for Lead Arsenate"). Discontinue applications after July 10 to avoid excessive harvest residues. Common formulation is wettable powder.

Methoxychlor

Controls leafhoppers, rose chafer, cherry fruit fly and apple maggot; also spittlebugs on strawberries.

Low toxicity to humans. For apple maggot, use in late season sprays. Common formulations are 2 pounds per gallon EC, 50% WP and 5 to 10% Dusts.

Ovex

Controls plant feeding mites. More effective against eggs and nymphs than adults.

Very low toxicity to warm-blooded animals. Common formulations are 40 to 50% WP and 20% EC.

Ryania

Controls late-season codling moth.

Moderately low toxicity to humans. Common formulations are 40 to 100% Dust and 40 to 100% WP.

Sevin

Controls aphids, codling moth, apple maggot, plum curculio, red-banded leaf roller, oriental fruit moth and catfacing insects.

Does *not* control mites. Particularly useful for late-season codling moth and apple maggot control. Moderately toxic to humans. Do *not* use in apple cover sprays until 30 days after full bloom. Common formulations are 50% WP, 85% WP, and 4 pounds per gallon flowable.

TDE (DDD)

Controls leaf rollers.

Moderately toxic to humans. Common formulations are 2 pounds per gallon EC, 50% WP and 5% Dust.

Tedion

Controls mites.

Low toxicity to humans. May be used in pre-bloom and cover sprays. Apply *no more* than 1 pound after first cover. Common formulation is 25% WP.

Thiodan

Controls aphids, spittlebugs, lygus bugs, stink bugs and flea beetles; also cyclamen mites in strawberries.

Follow label directions for safe use. Common formulations are 25 or 50% WP and 2 pounds per gallon EC.

Safeners for Lead Arsenate

Lead arsenate will injure most apple varieties unless it is safened. Injury may not show up after one or two applications, but chances are it will eventually appear.

Hydrated lime, ferbam, captan, dodine and Niacide may be combined with lead arsenate to prevent injury.

The following amounts of *any one* of these materials will safen *1 pound* of lead arsenate—¼ pound of ferbam, ¼ pound of dodine, ½ pound of captan, ½ pound of Niacide and 1 pound of hydrated lime.

Glyodin or thiram will *not* safen lead arsenate. When using these fungicides with lead arsenate, reduce the amount, and add either ferbam, captan or Niacide at the required safening rate. For example, if using glyodin at 1½ pints in 100 gallons of water with 3 pounds of lead arsenate, reduce the amount of glyodin to 1 pint, and add ¾ pound of ferbam.

Precautions in Using Pesticides

The U. S. Food and Drug Administration has put certain restrictions on the use of herbicidal and pesticidal chemicals. These restrictions are residue tolerances allowable on harvested fruit. A grower now must know what chemicals to use on what fruit, how to use them and when to use them with respect to harvest date. He must follow harvest restriction regulations to comply with the law and to assure protection of the consumer.

RULES FOR USING PHOSPHATES

All forms of parathion, TEPP, Guthion, Phosdrin, Phosphamidon and demeton are highly poisonous. They should not be applied unless users strictly follow these precautions:

1. When handling or spraying these materials, always wear a respirator made especially for protecting against phosphate poisoning.
2. Always wear protective clothing to cover as much of the body as possible.
3. Never handle highly poisonous phosphates with your bare hands. If you must handle them, wear natural rubber gloves, never synthetic rubber, leather or cloth gloves.
4. Avoid breathing these materials when opening the containers or transferring materials into spray tanks.
5. Wash hands, arms and face immediately after handling highly toxic phosphates and before eating or smoking. Never smoke while you handle these materials.
6. During the spray operation, work with your back to the wind, and avoid inhaling the spray mist. In fact, if conditions make it difficult to stay out of the spray drift, don't spray.
7. After each day's work, take a thorough shower, and change clothes.
8. Wear clean overalls, underwear, socks and cap each day you spray.

SYMPTOMS OF PHOSPHATE POISONING

Phosphate poisoning symptoms include headache, blurred vision, pinpoint pupils, weakness, nausea, cramps, diarrhea and discomfort in the chest. If you feel any of these symptoms when using phosphate pesticides, stop spraying or dusting immediately, and contact a doctor. Do not spray or dust again until the doctor has made a blood test.

If you get the symptoms of blurred vision or pinpoint pupils, take two atropine tablets at once, then see a doctor. Atropine is the emergency antidote for phosphate poisoning, and you should always keep it on hand. Since atropine can only be obtained on a doctor's prescription, arrange for a prescription from him. Each tablet should contain 1/100 grain. Never take atropine unless blurred vision or pinpoint pupil symptoms appear.

EMERGENCY TREATMENTS FOR POISONING

First, call a doctor at once. In most cases, prompt treatment is vital. But never give anything orally (by mouth) to an unconscious person.

If poison is inhaled, as in the case of toxic fumigants, carry the patient (don't let him walk) into the open air. Loosen his clothing, wrap him in blankets and keep him quiet. Give artificial respiration if breathing is irregular or has stopped.

If poison is spilled on the skin, scrub the skin immediately with plenty of warm soapy water.

If poison gets into the eyes, flush them with plain water.

If poison is swallowed, in most cases, empty the patient's stomach as soon as possible. Get the patient to vomit by having him drink a warm salt solution, a ground mustard solution (1 teaspoonful in a glass of water) or an ipecac solution (same dosage). Vomiting can also be caused by tickling the throat or by inserting the index finger or a tongue depressor far down the throat.

After emptying the stomach, feed the patient raw eggs, milk or a thin flour paste. These absorb the poison and soothe irritated membranes.

Instances when vomiting should *not* be induced are (1) if patient is unconscious or in a coma, (2) if patient is in convulsions, (3) if patient has swallowed petroleum products and (4) if patient has swallowed acid, acid-like corrosive or alkali corrosive poison.

If the specific poison is known, follow these emergency treatment recommendations:

Acids: Drink lime water, milk of lime or milk of magnesia.

Arsenic compounds: Empty stomach, then feed raw eggs, milk, lime water, flour and water, or sweet oil.

BHC, DDT and chlordane: Empty the stomach, then give hot tea or coffee and 1 ounce of Epsom salts. Physician may administer phenobarbital.

Mercury compounds: Feed raw eggs and milk immediately, empty the stomach, then give stimulants, such as hot tea or coffee.

Phosphates: Empty the stomach, then have physician administer 1/30 to 1/60 grain of atropine sulfate hourly, until pupils dilate.

POISON CONTROL CENTERS

Poison control centers are set up in Indiana and surrounding states to provide physicians with current information on diagnosing and treating accidental poisoning cases.

If accidental poisoning occurs, first call a physician or hospital. Give them information about the poisoning, especially the name of the toxic material.

Here is the current list of poison control centers in Indiana and surrounding states:

Table 1. Poison control centers in and around Indiana.

City	Name and address	Telephone	Director and assistant director
	Indiana		
Anderson	Poison Control Center St. John's Hickey Memorial Hospital 127 West 19th Street	3-3391	Sister Mary
East Chicago	Poison Control Center St. Catherine Hospital 4321 Fir Street	EXport 7-3080	Jack Troy, M.D.
Elkhart	Poison Control Center Elkhart General Hospital 600 East Boulevard	JA 5-3530 Ext. 224	C. R. Yoder, M.D.
Evansville	Poison Control Center Welborn Memorial Baptist Hospital 412 S. E. 4th Street	HArrison 3-3103	R. K. Glenn
Hammond	Poison Control Center St. Margaret Hospital 25 Douglas Street	WEstmore 2-2300	H. I. Arbeiter, M.D.
Indianapolis	Poison Control Center General Hospital 960 Locke Street	MElrose 6-6331	H. M. Parrish, M.D. R. W. Dyke, M.D.
	*Poison Control Center Indiana State Board of Health 1330 West Michigan Street	MElrose 4-8433 Ext. 226	A. C. Offutt, M.D.
Marion	Poison Control Center Marion General Hospital Wabash and Euclid Avenue	NOrth 4-2311	L. L. Diamond, M.D. Douglas Baily, M.D.
	Illinois		
Chicago	Poison Control Center Mercy Hospital 2537 South Prairie Avenue	VIctory 2-4700 Ext. 10	J. R. Christian, M.D. John O'Shea, M.D.
	Poison Control Center Presbyterian-St. Luke's Hospital 1735 West Congress Parkway	SEeley 8-4411	F. L. Phillips, M.D. Warren Dammers, M.D.
Danville	Poison Control Center Lakeview Hospital 812 North Logan Avenue	HIckory 6-7200	Margaret Arnold, R.N.
	Poison Control Center St. Elizabeth Hospital 602 Green Street	HIckory 2-6300	W. R. Elghammer, M.D. E. S. Brewster, M.D.
	Kentucky		
Louisville	* Poison Control Center Department of Pediatrics 323 East Chestnut Street	JUniper 2-1831	W. C. Adams, M.D.
	Ohio		
Cincinnati	* Poison Control Center Cincinnati Academy of Medicine 152 East 4th Street	PArkway 1-2345	
	Michigan		
Coldwater	Poison Control Center Community Health Center, Branch Co. 274 East Chicago Street	BRoadway 9-9501	J. C. Heffelfinger, M.D.

* Informational services only.

Concentrate Spraying for Orchards

Many growers are considering concentrate spraying as one way to cut the high cost of insect and disease control in the orchard.

WHAT IS IT?

Under conventional spraying methods, the normal gallonage of spray used at different seasons to wet one mature apple tree varies from 8 to 25 gallons. Such volume in a large, commercial orchard requires a readily available water supply, frequent refilling of the spray tank, a tractor driver and two spray men. It is expensive, time-consuming and makes it difficult to apply sprays as often as needed to maintain adequate coverage.

If the amount of water containing the pest control chemicals could be *reduced* to one-half, one-fourth or even one-eighth, with a corresponding increase in the concentration of spray chemicals, then theoretically, the same amount of chemical could still be applied to each tree but with a considerable saving in time. To achieve this, however, special equipment is required.

Recently, several concentrate fruit sprayers have been developed and are being tested. They use a high velocity air stream to give uniform distribution of spray chemicals delivered from stationary nozzles. These sprayers are known as air-blast applicators, and the use of reduced gallonages to apply the spray chemicals is called *concentrate spraying.*

NORMAL GALLONAGE

Normal gallonage is the number of gallons of dilute spray needed to wet trees of a certain age using a conventional, high-pressure sprayer equipped with booms, spray guns or masts. Normal gallonages required for two-sided coverage of a mature apple tree would be approximately as follows:

Table 2. Normal gallonage requirements—two-sided coverage of mature apple tree.

Spray period	Normal gallonage per tree
	gallons
Delayed dormant	7.5
Pre-pink	7.5
Pink	8.5
Bloom	10.0
Petal-fall	10.0
1st cover	12.5
2nd cover	15.5
3rd cover	17.5
4th cover	20.0

You can calculate gallonages for concentrate spraying from normal gallonage requirements. Of course, normal gallonages used to calculate concentrate gallonages require renozzling the air-blast sprayer for each application. Therefore, a base of 12 gallons is often recommended for calculating concentrate gallonage throughout the season. This results in somewhat greater gallonage as well as greater amounts of fungicide per tree in all the scab sprays up to first cover. But since apple scab is a major hazard during the early growing season, the increased amount of fungicide per tree is added insurance against scab.

Beginning with first cover, the seasonal base of 12 gallons for a two-side spray is less than normally used in conventional spraying. This then is a considerable saving in spray chemicals, labor and water.

CONCENTRATE FORMULAS

A 1x spray refers to normal gallonage containing standard amounts of chemicals. A 2x concentrate spray means one-half normal gallonage with twice the recommended strength of chemicals. A 3x spray is one-third normal gallonage and three times the recommended dosage of chemicals. Sometimes, sprays of twice normal chemical amounts are applied at one-third normal gallonage beginning with the first cover.

Table 3. Gallonages and chemicals required for different concentrations.

Concentration	Spray needed per tree	Chemicals in 100 gallons
	gallons	pounds
1x	12	3
2x	6	6
4x	3	12
6x	2	18
8x	1½	24

Thorough coverage is always important. So carefully study the spray pattern when the day's work starts, and readjust if wind conditions change.

The 12-gallon base recommended above requires the same total discharge from the battery of concentrate nozzles throughout the season. Because most concentrate spraying is done without turning off the spray between trees, allow for the material wasted.

Use the following formula to determine total nozzle discharge per minute for concentrate spraying.

If: R = Unknown gallons per minute needed
G = Regular gallonage per tree (12 gal.)
2 = One-side delivery only

F = Feet traveled per minute
D = Average spread of tree in feet
C = Concentration desired

$$\text{Then: } R = \frac{G \times F}{2 \times C \times D}$$

(Miles per hour to feet per minute: 1 mph = 88 fpm, 1½ mph = 132 fpm, 2 mph = 176 fpm, 3 mph = 264 fpm, 4 mph = 352 fpm.)

Example:

$$R = \frac{\text{(Reg. gallonage) } 12 \times \text{(2 miles per hour) } 176}{\text{(One side) } 2 \times \text{(Concentration) } 4 \times \text{(Spread) } 27}$$

$$R = \frac{2{,}112}{216} = 9.7 \text{ gallons total nozzle output needed per minute}$$

Compatibility of Fungicides and Insecticides

The ability of a fungicide to mix with an insecticide without impairing the efficiency of either and without injuring the plant is called "compatibility." When a fungicide cannot be mixed safely with another pest control chemical, it is said to be "incompatible" with that chemical.

The chart below shows the compatibility of the more common pest control materials.

Elemental sulfur, lead arsenate, dieldrin, endrin.

X	Lime-sulfur																						
X	N	Fixed copper																					
X	N	X	Bordeaux																				
X	N	?	?	Mercuries																			
X	X	X	X	?	Lime																		
X	?	?	?	X	N	Niacide																	
X	N	N	N	X	N	X	Captan																
X	?	?	?	X	N	X	X	Zineb, Ziram															
X	?	?	?	X	N	X	X	X	Ferbam, Thiram (Thylate)														
X	?	?	?	X	?	X	X	X	X	Dichlone, Phygon XL													
X	X	X	X	X	X	X	X	X	X	X	Glyodin												
X	O	O	O	?	O	X	X	X	X	X	X	Parathion, EPN 300											
X	?	X	X	X	O	X	X	X	X	X	X	X	DDT, DDD, TDE										
X	O	O	O	?	O	X	X	X	X	X	X	X	X	Malathion, Trithion									
X	?	?	?	?	O	X	X	X	X	X	X	X	X	X	Systox (demeton)								
X	?	?	?	X	N	X	X	X	X	X	X	X	X	X	X	Guthion, Diazinon							
X	N	X	N	N	N	?	X	X	X	X	X	X	X	X	X	X	Sevin						
X	?	X	X	X	?	X	X	X	X	X	X	X	X	X	X	X	X	Methoxychlor					
X	N	N	N	X	N	X	X	X	X	X	X	X	X	X	X	X	X	X	BHC (Lindane)				
X	N	N	N	X	N	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Kelthane, Aramite			
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Ovex, Genite		
X	?	N	N	X	N	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Chlorabenzilate	
X	X	?	?	X	?	X	X	?	X	?	?	X	X	X	?	X	?	X	X	?	?	?	Tedion, Mitox
X	?	?	?	X	?	X	X	X	X	X	X	X	X	?	X	X	X	X	X	X	X	X	X Karathane
X	X	X	X	X	X	X	X	X	X	X	N	X	X	X	X	X	X	X	N	X	X	?	? X Streptomycin
X	N	?	N	?	N	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	N	X X X Cyprex

Key to Symbols

X = materials compatible
N = materials not compatible
? = questionable
O = decomposes on standing, i.e., residual action reduced

Converting and Diluting Dosages

Growers are constantly faced with the puzzling problem of converting recommended pesticide chemical dosages to smaller or larger units. The following tables are compiled to simplify the problem of converting dosage, rates and volumes recommended for modern fungicides and insecticides.

Table 4. Measures equivalents.

Unit	Equivalents
1 tablespoonful (tbsp)	3 teaspoonsful (tsp) or 15 milliliters (ml) or 15 cubic centimeters (cc) or ½ fluid ounce (fl oz)
1 cupful (c)	16 tbsp or 8 fl oz or 236.6 cc or ½ pint (pt)
1 pint (pt)	16 fl oz or 473 cc (A pint or quart dry measure is about 16% larger than liquid measure)
1 U.S. gallon (gal)	4 quarts (qt) or 8 pt or 3,785.4 ml or 3,785.4 cc or 231 cubic inches (cu in) or 8.3358 lb water capacity
1 liter	1,000 ml or 1,000 cc
1 pound (lb)	16 oz or 453.49 grams (gm)
1 ounce (oz)	28.3358 gm
1 fluid ounce (fl oz)	2 tbsp or 29.6 ml or 29.6 cc
1 bushel of soil	1.25 cubic feet (cu ft)
1 mile	5,280 ft or 320 rods
1 acre	43,560 square feet (sq ft) or 160 sq rods

Table 5. Rates of application equivalents.

Unit	Equivalents
1 ounce per square foot	2722.5 pounds per acre
1 ounce per square yard	302.5 pounds per acre
1 ounce per 100 square feet	27.2 pounds per acre
1 pound per 100 square feet	435.6 pounds per acre
1 pound per 1,000 square feet	46.3 pounds per acre
1 pound per acre	⅓ ounce per 1,000 square feet
5 gallons per acre	1 pint per 1,000 square feet
100 gallons per acre	2.5 gallons per 1,000 square feet or 1 quart per 100 square feet

DILUTION FORMULAS

Wettable powders (lbs. of concentrate to use) =

$$\frac{\text{Tot. gals.} \times \text{finished concentration (\%)} \times 8.35}{\text{Concentration of wettable powder (\%)}}$$

Example: To make 8 gallons of a ½% suspension from 25% wettable powder—

$$\frac{8 \times 0.5 \times 8.35}{25} = 1.35 \text{ lbs. of concentrate in 8 gal.}$$

Table 6. Approximate proportions for mixing sprays.

Formulation	Unit	Amount formulation to use when desired percent of chemicals in mixture is to be—						
		.0625%	0.125%	0.25%	0.5%	1.0%	2.0%	5.0%
10%-12% E C containing 1 lb chemical per gal	in 100 gal (in 1 gal)	4 pt (4 tsp)	1 gal (8 tsp)	2 gal (16 tsp)	4 gal (10 tbsp)	8 gal (⅔ pt)	16 gal (1⅓ pt)	41 gal (3⅓ pt)
15%-20% E C containing 1½ lb chemical per gal	in 100 gal (in 1 gal)	3 pt (3 tsp)	6 pt (6 tsp)	1½ gal (12 tsp)	3 gal (7½ tbsp)	6 gal (½ pt)	12 gal (1 pt)	27 gal (2¼ pt)
25% E C containing 2 lb chemical per gal	in 100 gal (in 1 gal)	2 pt (2 tsp)	4 pt (4 tsp)	1 gal (8 tsp)	2 gal (5 tbsp)	4 gal (10 tbsp)	8 gal (⅔ pt)	20 gal (1⅔ pt)
33%-35% E C containing 3 lb chemical per gal	in 100 gal (in 1 gal)	1½ pt (1½ tsp)	3 pt (3 tsp)	6 pt (6 tsp)	1½ gal (4 tbsp)	3 gal (8 tbsp)	6 gal (½ pt)	14 gal (1 pt)
40%-50% E C containing 4 lb chemical per gal	in 100 gal (in 1 gal)	1 pt (1 tsp)	2 pt (2 tsp)	4 pt (4 tsp)	1 gal (8 tsp)	2 gal (5 tbsp)	4 gal (11 tbsp)	10 gal (⅘ pt)
57% E C containing 5 lb chemical per gal	in 100 gal (in 1 gal)	⅞ pt (⅞ tsp)	1¾ pt (1¾ tsp)	3½ pt (3½ tsp)	7 pt (7 tsp)	1¾ gal (4½ tbsp)	3½ gal (9 tbsp)	8 gal (⅔ pt)
60%-65% E C containing 6 lb chemical per gal	in 100 gal (in 1 gal)	¾ pt (¾ tsp)	1½ pt (½ tbsp)	3 pt (1 tbsp)	6 pt (2 tbsp)	1½ gal (4 tbsp)	3 gal (8 tbsp)	7 gal (½ pt)
70%-75% E C containing 8 lb chemical per gal	in 100 gal (in 1 gal)	½ pt (½ tsp)	1 pt (1 tsp)	2 pt (2 tsp)	4 pt (4 tsp)	1 gal (8 tsp)	2 gal (5 tbsp)	5 gal (⅖ pt)
15% W P	in 100 gal (in 1 gal)	3⅓ lb (5 tsp)	6⅔ lb (10 tsp)	13⅓ lb (7 tbsp)	26⅔ lb (1 cup)	53⅓ lb (2 cups)	106⅔ lb (4 cups)	278 lb
25% W P	in 100 gal (in 1 gal)	2 lb (3 tsp)	4 lb (6 tsp)	8 lb (12 tsp)	16 lb (8 tbsp)	32 lb (1 cup)	64 lb (2 cups)	167 lb
40% W P	in 100 gal (in 1 gal)	1¼ lb (2 tsp)	2½ lb (4 tsp)	5 lb (8 tsp)	10 lb (5 tbsp)	20 lb (10 tbsp)	40 lb (1¼ cups)	104 lb
50% W P	in 100 gal (in 1 gal)	1 lb (1½ tsp)	2 lb (3 tsp)	4 lb (6 tsp)	8 lb (4 tbsp)	16 lb (8 tbsp)	32 lb (1 cup)	83 lb
75% W P	in 100 gal (in 1 gal)	⅔ lb (1 tsp)	1⅓ lb (2 tsp)	2⅔ lb (4 tsp)	5⅓ lb (8 tsp)	10⅔ lb (5 tbsp)	21⅓ lb (10 tbsp)	55 lb

Table 7. Amount (weight) of powder required to prepare different amounts of spray mixture at different dosage levels.

Recommended dosages per 100 gallons			Amount of powder required to prepare spray for—									
			50 gallons		20 gallons		10 gallons		5 gallons		1 gallon	
lb	oz	gm	oz	gm	oz	gm	oz	gm	oz	gm	oz	gm
0.25	4	113	2	56	0.8	23	0.4	11	0.2	6	0.04	1
0.50	8	227	4	113	1.6	45	0.8	23	0.4	11	0.08	2
1.00	16	454	8	227	3.2	91	1.6	45	0.8	23	0.16	5
1.50	24	681	12	340	4.8	136	2.4	68	1.2	34	0.24	7
2.00	32	908	16	454	6.4	182	3.2	91	1.6	45	0.32	9
3.00	48	1,362	24	681	9.6	272	4.8	136	2.4	68	0.48	14
4.00	64	1,816	32	908	12.8	363	6.4	182	3.2	91	0.64	18
5.00	80	2,270	40	1,135	16.0	454	8.0	227	4.0	113	0.80	23

Table 8. Amount (volume) of liquids required to prepare different amounts of spray mixtures at different dilutions.

Dilution required	Recommended dosage of chemical in 100 gallons			Amount of liquid required to prepare spray for—								
				50 gallons		20 gallons		10 gallons		5 gallons		1 gallon	
	cup	pt	qt	pt	cc	pt	cc	cc	tsp	cc	tsp	cc	tsp
1-3200	0.5	0.25	0.12	0.125	59.2	0.05	23.7	11.8	2.4	5.9	1.2	1.2	0.2
1-1600	1.0	0.50	0.25	0.250	118.3	0.10	47.7	23.7	4.8	11.8	2.4	2.4	0.5
1-800	2.0	1.00	0.50	0.500	236.6	0.20	94.6	47.3	9.6	23.7	4.8	4.7	1.0
1-400	4.0	2.00	1.00	1.000	473.2	0.40	189.3	94.6	19.2	47.3	9.6	9.5	1.9
1-200	8.0	4.00	2.00	2.000	946.4	0.80	378.6	189.3	38.3	94.6	19.2	18.9	3.8
1-100	16.0	8.00	4.00	4.000	1,892.8	1.60	757.1	378.6	76.6	189.3	38.3	37.9	7.7
1-50	32.0	16.00	8.00	8.000	3,785.6	3.20	1,514.2	757.2	153.2	378.6	76.6	75.7	15.3
1-25	64.0	32.00	16.00	16.000	7,571.2	6.40	3,028.5	1,514.2	306.4	757.1	153.7	151.4	30.6

Table 9. Gallons per acre required to spray orchards of different planting distances (square planting).

Distance between trees	Gallons per acre when per tree requirements are—							
	2 gallons	5 gallons	7 gallons	9 gallons	10 gallons	12 gallons	15 gallons	20 gallons
feet	gallons							
18	268	670	938	1,206	1,340	1,608	2,010	2,680
20	218	545	763	981	1,090	1,308	1,635	2,180
21	198	495	693	891	990	1,188	1,485	1,980
22	180	450	630	810	900	1,080	1,350	1,800
24	150	375	525	675	750	900	1,125	1,500
25	140	350	490	630	700	840	1,050	1,400
30	96	240	336	432	480	576	720	960
35	72	180	252	324	360	432	540	720
40	54	135	189	243	270	324	405	540
45	44	110	154	198	220	264	330	440
50	34	85	119	153	170	204	255	340

Table 10. Converting fungicides from pounds per 100 gallons to tablespoonsful per gallon.

Fungicide	Tablespoonsful per gallon when 100 gallons calls for—						
	½ pound	1 pound	1½ pounds	2 pounds	4 pounds	6 pounds	8 pounds
	tablespoonsful						
Captan 50% WP	3/8	3/4	1 1/8	1½	3	4½	6
Chloranil 96% WP	½	1	1½	2	4	6	8
Copper sulfate (snow)	1/6	1/3	½	2/3	1 1/3	2	2½
Dichlone 50% WP	1/3	2/3	1	1 1/3	2 2/3	4	5 1/3
Ferbam 75% WP	5/8	1¼	1¾	2½	5	7½	10
Fixed copper 50%	¼	½	¾	1	2	3	4
Karathane	1/3	2/3	1	1 1/3	2 2/3	4	5 1/3
Maneb 80% WP	¼	½	¾	1	2	3	4
Spray lime	½	1	1½	2	4	6	8
Terraclor 75% WP		1		2			
Thiram 75% WP	3/8	¾	1 1/8	1½	3	4½	6
Wettable sulfur	¼	½	¾	1	2	3	4
Zineb 65% WP	1/3	2/3	1	1 1/3	2 2/3	4	5 1/3
Ziram 76% WP	5/8	1¼	1¾	2½	5	7½	10

Apple Production Problems

This section deals with problems common to apple production. The grower is usually faced with most, if not all, of these situations every year. They include special insect and disease control problems, chemical thinning, scald, preharvest drop and special finish problems.

While the chemical recommendations for scab, fireblight, summer rot and mite control are outlined in Mimeo ID-60, "Indiana Fruit Spray Schedules," these common apple problems merit special attention and are discussed here.

SPECIAL DISEASE CONTROL PROBLEMS

Apple Scab

Scab is usually the most serious apple disease problem. During the winter and early spring, the scab fungus develops in old leaves on the ground that were infected the previous season. It produces ascospores that mature about the time the first green apple tissue is exposed.

Rain sufficient to wet the surface of the old leaves will cause some of these ascospores to be shot into the air. Winds then carry these spores into adjoining trees. The spores that land on green apple foliage or fruit cause primary infection if they and the green tissue stay wet for a few hours. Discharge of ascospores may continue as long as 2 to 4 weeks after petal fall, but they are usually gone by first cover.

Spores will germinate and penetrate into wet green tissue. The time required for germination and primary infection depends upon the temperature during the wet period (Table 11). (A "wet period" is defined as that period during which developing apple leaves remain continuously wet with rain or dew.)

Table 11. Hours of continued wet foliage required for primary scab infection at different temperatures.

Temperature	Hours of wet period required for primary infection
degrees F.	hours
32-40	48
41-42	30
43-45	20
46-50	14
51-53	12
54-58	10
59-76	9
76+	11

Primary scab infection is soon followed by the formation of numerous secondary spores (conidia) in established scab spots. How soon these spores appear after primary infection also depends on the weather (Table 12).

Once primary infection is established, it is possible for both ascospores and conidia to be present at the same time. The conidia are spread only by dropping or splashing water and thus infect only nearby fruit and foliage. Infection by conidia requires a wet period about 3 hours shorter than for ascospore infection.

Table 12. Time required for secondary scab infection at different temperatures.

Temperature	Days required for conidia development following primary infection
degrees F.	days
30-40	18
41-45	16
46-50	14
51-55	13
56-60	12
61-65	10
66-70	8
71-75	7

By knowing the temperatures from the time the green tissue first becomes wet until it dries again, you can determine from tables 11 and 12 if infection is likely and can judge whether the spray materials already applied are adequate. If weather predictions indicate that the wet period will extend beyond the time given for apple scab infection, you should apply a protective spray before or during the wet period, or an eradication spray immediately after the wet period. Renewed protection or eradication is particularly necessary if you have any doubts about the protective cover already present.

Fireblight

Fireblight continues to be destructive in some areas of the state. And at present there is no completely effective control. No experimental material has proven to be any more effective than streptomycin.

Correct timing of streptomycin applications is extremely important for control. Apply streptomycin at 75 parts per million any time after any blossoms are open if either of the following conditions exist or are expected within 24 hours:

1. Maximum temperatures of at least 65° F. *plus* rainfall.
2. Maximum temperatures of at least 65° F. *plus* relative humidity of 60% or higher.

If these conditions continue until ¾ of the blossoms are open or if they recur at that time, make a second application of streptomycin at 75 ppm. To reduce the possibility of secondary twig blight, make a third application in early petal fall.

Summer Rot

Summer diseases of apple include blotch, sooty blotch, fly speck, bitter rot, Brook's fruit spot, black pox, black rot and bot rot.

Varieties vary in susceptibility to these diseases. In general, however, the early maturing varieties are more susceptible to bitter rot; Red Delicious and its red sports are more susceptible to black rot; Grimes Golden is very susceptible to blotch; Golden Delicious and Grimes Golden are very susceptible to sooty blotch and flyspeck; while Grimes Golden, Golden Delicious, Rome and Gallia Beauty and their red sports are more susceptible to bot rot.

The critical period for black rot control is during bloom and in early fruit development. Other summer diseases develop during the cover spray periods.

Fungicide combinations give the best control of summer diseases. Zineb at 1 pound in 100 gallons of water *plus* half-strength organic fungicides, such as captan, niacide, glyodin and dodine, are suggested.

Folpet (Phaltan) has given excellent summer disease control in experimental orchard trials. Do not use folpet until the third cover.

SPECIAL INSECT CONTROL PROBLEMS

Mites

Plan your mite control program. Use a dormant oil application or an oil-phosphate combination spray during the dormant stage. If dormant sprays are not used, then apply mite sprays during the pre-pink stage. For early season control of European red mites, apply a miticide before bloom. During the season, use both phosphate and non-phosphate miticides to insure adequate control and delay possible build-up of resistance.

To avoid or delay build up of resistance, rotate use of the different types of miticides. One simple but effective rotation would be:

Dormant oil in early season each year, *then* either (1) an organophosphate, (2) a chlorinated hydrocarbon or (3) a sulfur-based compound in mid-summer.

By using a miticide from each one of these groups each year, you will have a 3-year rotation that should give effective, long-run control.

Organophosphates include demeton, diazinon, ethion, guthion, malathion, parathion, phosdrin, phosphamidon, trithion and TEPP. Chlorinated hydrocarbons are kelthane and chlorobenzilate. Sulfur-based compounds are chlorbenside, genite, ovex and tedion.

Periodical Cicadas

In 1963 and 1966, periodical cicadas will again appear in Indiana. These cicadas are also called "17-year or 13-year locusts." They are about 1⅝ inches long and are black with red legs, wing margins and eyes. They may appear any time from the last of May until the first of July. In 1963, brood No. XXIII (13-year) will appear in 21 counties—mostly in southwestern Indiana, with Fountain, Tippecanoe and Fayette counties being northern limits. Brood VI (17-year) should appear in 1966 in 24 counties—particularly Boone, Brown, Carroll, Grant, Johnson, LaPorte and Wells. This brood should not be very numerous in any one locality.

For effective control, apply Sevin 50% WP at 2 pounds in 100 gallons of water as soon as egg laying begins. Repeat application 7 to 10 days later. Egg laying is indicated by slits or punctures in the small branches and twigs of fruit trees. Do not apply Sevin to producing trees until 30 days after full bloom, since it may cause fruit thinning. Sevin has a one day harvest restriction.

TEPP may be used instead of Sevin. Apply TEPP 40% EC at ¼ to ½ pint in 100 gallons of water. This highly toxic insecticide is effective only as a contact spray. Observe all label precautions for safe handling.

ORCHARD MICE PROBLEMS

Mice damage can be very serious in orchards. Satisfactory mouse control can usually be obtained by several different practices.

Protecting Young Plantings

A band of cinders or gravel around the base of young trees tends to discourage mouse activity. A galvanized wire guard of ½ inch or smaller mesh placed around the trunk also gives some protection. The "hardware cloth" is cut into 14 x 18-inch or 24 x 18-inch pieces and placed around the trunk with the lower edges pushed into the ground. Baiting may be a necessary supplement where the possibility of heavy snow cover exists.

Baiting

Orchard baiting is performed in October and November when mice begin to confine themselves to rather limited areas. Several poisonous baits are available from chemical companies and the U. S. Fish and Wildlife Service, AES Building, Purdue University, Lafayette, Indiana. These baits include zinc phosphide, strychnine-treated oats and zinc phosphide-treated corn or oats.

The zinc phosphide is mixed with apple pieces cut into ½-inch squares. One teaspoonful of poison is mixed with 1 quart of apple cubes. The bait is placed in four to six active runways under each tree. Use only fresh bait.

A poison grain bait of zinc phosphide-treated corn may be broadcast under the trees at 8 to 10 pounds per acre. Two applications may be necessary in areas of heavy mouse activity. Be sure to treat border areas.

Endrin Ground Sprays

This post harvest practice is suggested only in case of a severe mouse problem. Use endrin at 0.4 to 0.6 pound actual in 100 gallons of sprays, and apply at 350 gallons of spray mixture per acre. The 0.4 pound actual rate is suggested for meadow mice and the 0.6 pound actual rate for pine mice.

Apply with a hand gun or spray boom using at least 500 pounds pressure. The boom should extend under the trees, and the strip to be sprayed should not be disturbed 2 months before and after endrin spraying. If vegetation is heavy, it is best not to mow before spraying.

Endrin ground sprays contaminate mice trails on the soil surface. Without above ground trails, there is no reason for applying endrin.

Endrin is very toxic and should be applied only with extreme caution! Avoid contact with the spray mixture. Apply endrin ground sprays only after harvest is completed and after all desired drops are removed from the orchard. *Post all treated areas,* stating that a poison ground spray has been applied.

Fish are easily poisoned by endrin. Do not wash sprayers or contaminated containers in streams or ponds, and do not spray orchards where run-off may drain into farm ponds, streams or other bodies of water.

CHEMICAL THINNING

The demand for annual bearing trees and medium to large-size apples has made fruit thinning an important commercial practice in Indiana. Application rates for the fruit thinning chemicals naphthalene acetic acid (NAA) and naphthalene acetamide (Amid-Thin) are suggested for various varieties in Table 13.

Apply Amid-Thin in the late bloom to petal-fall periods. Applications later than 4 to 5 days after petal-fall tend to result in no thinning. In addition, affected fruit remains on the tree, and a crop of small, worthless "pygmies" is produced.

Table 13. Application rates of fruit thinning chemicals on different varieties.

Variety	Chemical	
	NAA	Amid-Thin
	parts per million	
Summer varieties	--	50
Wealthy	20	75
Jonathan	10	50
McIntosh	10	60
Cortland	10	50
Grimes Golden	10	50
Red Delicious	10	37.5
Golden Delicious	20-25	60
Stayman, Turley and Winesap	10	37.5
Rome and Gallia Beauty	20	60

Apply NAA 10 to 27 days after full bloom. Delaying application tends to reduce foliage injury. Reduced concentrations of NAA *plus* ¾ pint of Tween 20 have produced uniform, dependable thinning results under various weather conditions. Foliage wilting is also greatly reduced. Use half-strength NAA with Tween 20 on difficult-to-thin varieties, such as Golden Delicious, Rome and Gallia Beauty. On others, use one-third strength NAA with Tween 20.

The insecticide Sevin also possesses apple thinning properties. Limited research indicates that Sevin 50% WP at ¾ to 1 pound in 100 gallons of water applied 15 to 21 days after full bloom, has thinned Jonathan, Delicious, Rome Beauty and Winesap. Golden Delicious requires 1½ pounds.

Important Reminders About Chemical Thinning

NAA generally gives best results under fast drying conditions and when the temperature is between 70 to 75° F. Amid-Thin gives the best results under slow drying conditions and is often applied in the evening.

Thorough spraying is necessary for satisfactory results. However, if you want to reduce the degree of thinning or are afraid of over-thinning, reduce the concentration but not the gallonage applied per tree.

Applying chemical thinning sprays after frost or freezing temperatures is risky. Foliage exposed to such conditions absorbs chemicals much more readily, and over-thinning may result. If you must spray under such conditions, reduce the concentration 25 to 30 percent.

Chemical thinners are generally more effective under the following conditions: (1) low tree vigor, (2) light pruning, (3) heavy bloom, (4) poor pollination, (5) high humidity before spraying, (6) slow drying of spray, (7) poor air drainage

and (8) cloudy, cool weather preceding or following the bloom period.

You should keep records of the conditions prevailing when you make applications and should leave several trees unsprayed to critically evaluate the results of thinning applications. This way you will be able to work out the concentrations best suited for your orchard conditions.

PRE-HARVEST DROP

Chemical growth regulators are used to prevent normal dropping for a few days to allow apples to obtain better color, size and maturity or to allow greater flexibility in harvesting.

Naphthalene acetic acid (NAA) is effective on all varieties. Apply it at 10 parts per million (ppm) for summer varieties, 15 ppm for fall varieties and 20 ppm for winter varieties. Make application about 3 to 4 days before expected fruit drop and during the warm part of the day, preferably when the temperature is above 65° F. The stop-drop effect lasts about 7 to 10 days. If harvest must be delayed beyond this period, make a second application.

NAA can be used at maximum dosage of 20 ppm but must not be applied more than twice. A 0.2% Dust is equivalent to a 20 ppm spray. NAA cannot be applied within 2 days of harvest.

2,4,5-TP (2,4,5-trichlorophenoxy propionic acid) is one of the best stop-drop sprays to control pre-harvest dropping of late varieties. Apply it at 10 ppm on fall varieties and 20 ppm on winter varieties. Only one application at a maximum dosage of 20 ppm is permitted. For best results, apply about 7 to 10 days before expected normal drop. Generally, an application is effective for about 4 weeks. 2,4,5-TP tends to hasten fruit maturity if applied too early in the fall or at too high a concentration. It is not suggested for summer varieties or Grimes Golden, since it causes considerable cracking of the fruit while on the tree.

Important Reminders About Pre-Harvest Drop Control

Stop-drop sprays enable you to leave fruit on the tree to obtain additional color. However, the fruit continues to ripen and may have little or no storage life if harvest is delayed. *So pick your fruit on time.*

Healthy leaves and thorough coverage are necessary for maximum effectiveness. Mite injury or nutritional deficiencies may reduce the degree of drop control.

For winter varieties, be sure to apply NAA or 2,4,5-TP before the leaves are injured by frost or old age.

Spraying too early or at too high a concentration may hasten maturity and decrease potential storage life. Concentrations of 2,4,5-TP higher than 10 ppm may cause cracking of skin flesh of Golden Delicious and Grimes.

Heavy bearing trees tend to drop more than similar trees with only a light or moderate crop. Spot picking does not seem to reduce this.

Fruit may begin to drop extensively within 3 to 5 days after a killing frost despite prior application of growth regulators.

SPECIAL FINISH PROBLEMS

Russeting

Low temperatures and chemicals applied between the pre-pink and second cover periods affect fruit finish. Temperatures of 32° F. or lower during this period may cause certain varieties to russet, especially Golden Delicious and Jonathan. The longer the period of low temperature, the more severe the russeting is likely to be. For example, a temperature of 28° F. for ½ hour is less harmful than a temperature of 30° F. for 12 to 14 hours.

Russeting may become very serious if certain chemicals are applied in conjunction with these low temperatures. (These chemicals are discussed under "Fungicides and Apple Finish" and "Insecticides and Apple Finish" below.)

Russeting caused by low temperatures alone appears as a rough, corky ring encircling the fruit. Russeting caused by a combination of low temperatures and spray chemicals usually appears as a netting or patch of corky tissue on the cheek of the fruit. In the pre-pink period, russeting will occur at the calyx end. Later in the season, it tends to occur toward the stem.

High pressure spraying seems to cause more russeting than air blast spraying. Adding a wetting agent to certain spray chemicals also may increase russeting.

Fungicides and Apple Finish

Liquid lime-sulfur should be used with caution on all apple varieties. It is a caustic material and should not be applied after bloom. Summer use will result in poor finish on most varieties and will reduce fruit bud development. Never apply liquid lime-sulfur unless it will dry in 10 to 15 minutes.

Wettable sulfurs applied in hot weather (above 80° F.) may cause "sunburn" on the southwest side of trees. Certain varieties are sulfur sensi-

tive and will not tolerate repeated summer application. Therefore, replace wettable sulfurs with organic fungicides during the summer sprays.

Mercury fungicides will eradicate scab, but excessive amounts cause yellow leaf and premature defoliation. Never use mercury fungicides after petal-fall, and never apply them on top of ferbam residues. Three sprays at full strength is about the tolerance limit for most varieties.

Ferbam, mercury, glyodin or dodine may russet Golden Delicious, even in years when no freezing temperatures occur after pre-pink. So do not use these materials from pre-pink through second cover. However, they may be used before pre-pink without danger of added fruit russeting. Captan, Niacide and thiram may be safely used any time during the growing season.

Dichlone plus glyodin, or ferbam alone or ferbam plus another fungicide may russet Jonathan when temperatures of 32° F. or below occur after pre-pink. However, dichlone *plus* captan, or dichlone *plus* wettable sulfur *or* dichlone *plus* Niacide *or* these fungicides alone may be used any time on Jonathans without danger of russeting. Do not use more than ¼ pound of dichlone in 100 gallons of water except before pre-pink.

Insecticides and Apple Finish

Some insecticides and miticides may cause fruit and foliage injury when applied under adverse weather conditions or when improperly combined with certain other insecticides and/or fungicides. In general, injury and russeting may occur when materials are applied during low temperatures and under slow drying conditions.

Demeton causes injury to Golden Delicious when more than ½ pint in 100 gallons of water is applied.

Diazinon may cause russeting if used in first or second cover spray.

EPN should not be used on McIntosh and related varieties.

Ethion should not be used on Melba or Wealthy.

Parathion sometimes causes fruit and foliage injury to McIntosh and may cause russeting of Golden Delicious in early cover sprays. Do not use more than recommended.

TEPP has caused injury under adverse weather conditions.

Trithion may cause leaf burn under slow drying conditions, and foliage injury and possible russeting if applications are repeated within 30 days.

BHC may russet Golden Delicious. Do not use later than pink spray because of off-flavored fruit at harvest.

Chlorobenzilate should not be used on Delicious, Jonathan, and McIntosh.

Chlorbenside and Genite-923 may cause russeting when used too close to bloom or during slow drying conditions.

Methoxychlor should not be used in the emulsion form in spray mixtures with fungicides.

Sevin should not be applied until 30 days after full bloom. This will avoid possibility of thinning.

APPLE SCALD

In mild cases, apple scald is identified by small areas on the unblushed side of the apple that have become slightly tinted with brown. In more severe cases, larger areas of the surface are dark brown and slightly depressed.

Factors Favorable to Scalding

Varieties vary in susceptibility to scald—the more susceptible being Grimes Golden, Cortland, Stayman, Winesap and Rome Beauty. Scald seldom is serious on Jonathan, McIntosh or Golden Delicious. Apples picked before they are mature are also more susceptible to scald.

While scald is most severe on green apple cheeks, it can also be serious on highly-colored red sports of Rome, Stayman and Delicious. In general, large apples are more susceptible than small ones.

It has been reported that high temperatures during the 6 weeks before harvest increase susceptibility. Also, fruit from heavily-irrigated trees or from trees that have received heavy late rainfall often develop much more scald. An indication of scald intensity may be obtained by storing a few apples in unsealed polyethylene bag liners at 70° F. for 6 weeks immediately after harvest.

Preventing Scald

The following practices are suggested for preventing or reducing scald losses:

1. Pick only mature fruit.
2. Rapidly cool and store fruit at 31 to 32° F.
3. Distribute ½ to ¾ pound of shredded oil paper *evenly* throughout the bushel of apples before storing. Using only a handful on top of the package for decorative purposes is of no value in scald control.
4. Use chemical scald inhibitors ethoxyquin or diphenylamine (DPA) as pre-harvest tree sprays or as fruit dips after harvest and before storage. This is at least twice as effective as oiled paper wraps.

Tree sprays of ethoxyquin or DPA have been more satisfactory for late season varieties than for early varieties.

As tree sprays, use ethoxyquin at 3 pints per 100 gallons of water (2,700 ppm) for pre-harvest application or at 2 pints per 100 gallons of water for post-harvest treatment. Use DPA 83% WP at 2 pounds per 100 gallons of water (2,000 ppm) for most varieties. For Rome, Grimes and Baldwin, use DPA at 1 pound or 1,000 ppm, since fruit injury sometimes results from higher concentrations. DPA is more effective than ethoxyquin as a tree spray.

These chemical scald inhibitors are sprayed onto the trees immediately before harvest. Thorough coverage is necessary. Spray the evening before or the early morning of the harvest day, but do not apply when the temperature is above 80° F. Harvest fruit within 36 hours after spraying.

If spot picking is practiced, make a second application before the second harvest. Use one material for the first harvest and the other for the later harvest so as not to exceed residue tolerances. Heavy or all-day rain following application will reduce control. Tree-sprayed fruit can be stored immediately and does not need a special treatment label when sold.

As post-harvest dips, ethoxyquin or DPA are flooded over or sprayed on the fruit during grading. This is more effective than tree spraying. Apply immediately after harvest and before storing. Applying the material on warm fruit (60 to 80° F.) gives better coverage than applying it to cold fruit. A hundred gallons of fruit dip solution should treat 1,000 bushels. Keep the suspension well agitated, and flush out small particles of DPA in the bottom of the tank when refilling.

DPA-treated fruit must be well drained before storing because of the danger of skin burning.

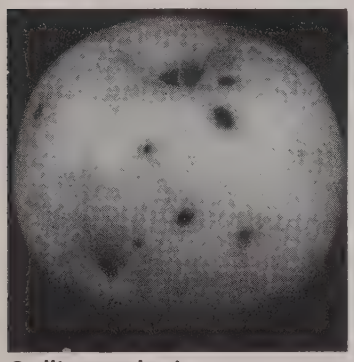
Ethoxyquin will fluoresce under long-wave ultraviolet light. Measuring the fluorescence on the fruit surface after the chemical has dried, therefore, is considered a good method of determining the degree of coverage.

Precautions with Scald Inhibitors

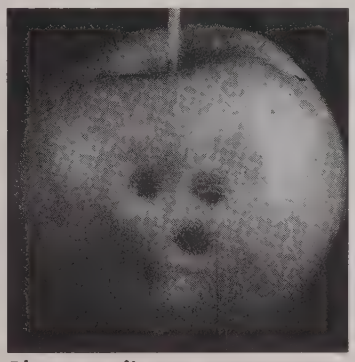
Wear plastic or rubber gloves if DPA wraps are used or wet, treated fruit is to be handled for long periods. Do not inhale DPA dusts.

All post-harvest treated fruit must have a stamp or label on the shipping containers stating that DPA or ethoxyquin has been used. The label should read: TREATED WITH ETHOXYQUIN (OR DIPHENYLAMINE) TO RETARD SPOILAGE (SCALD).

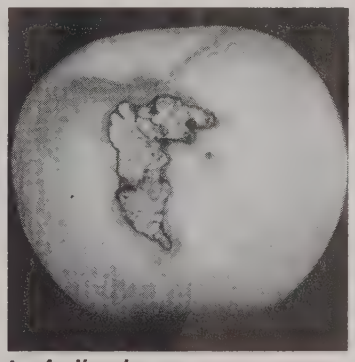
COMMON APPLE INSECT DAMAGE



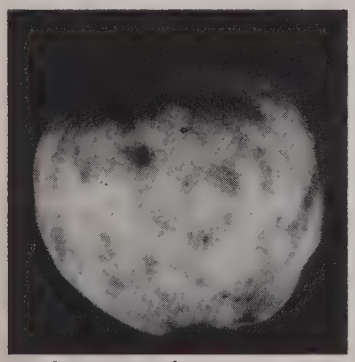
Codling moth stings



Plum curculio scars

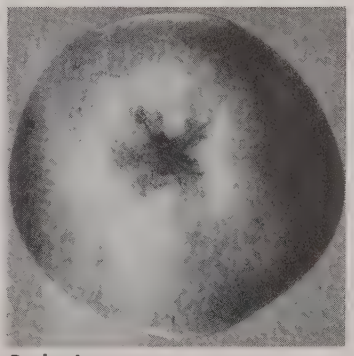


Leafroller damage



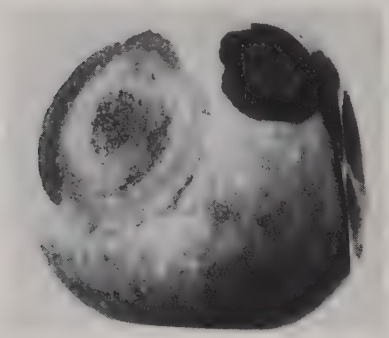
Apple maggot damage

Rosy aphid damage



Red mite eggs

COMMON APPLE DISEASE DAMAGE

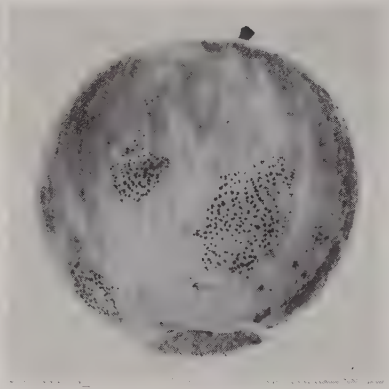


Bitter rot

Cedar rust

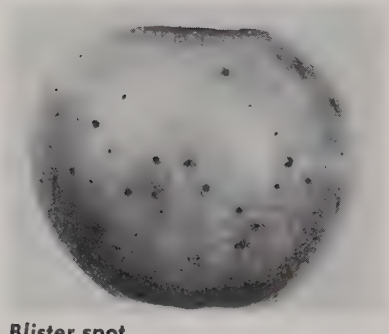
Bot rot

Black pox



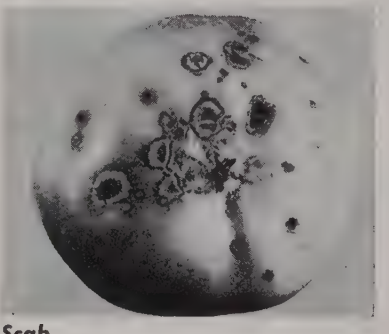
Fly speck and sooty blotch

Blotch



Blister spot

Powdery mildew

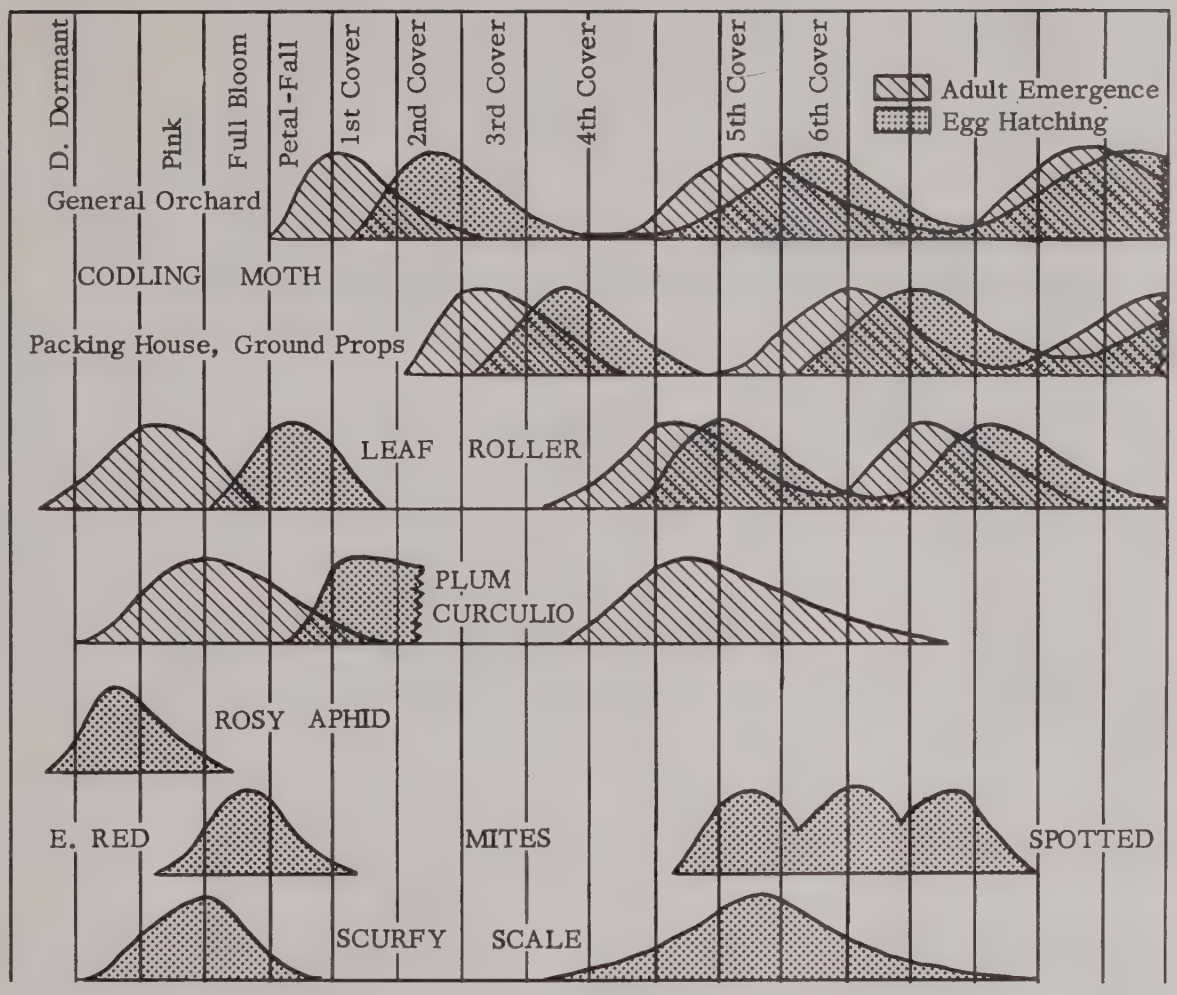


Scab

FRUIT SPRAY NEWSLETTER

A Cooperative Extension fruit spray newsletter is available at frequent intervals during the fruit season to all Indiana fruit growers at no cost. This service supplies timely information on disease and insect activity throughout the state. To obtain this service, send your name, address and present fruit acreage to the Department of Horticulture, Purdue University, Lafayette, Indiana.

ACTIVITY OF COMMON APPLE INSECTS



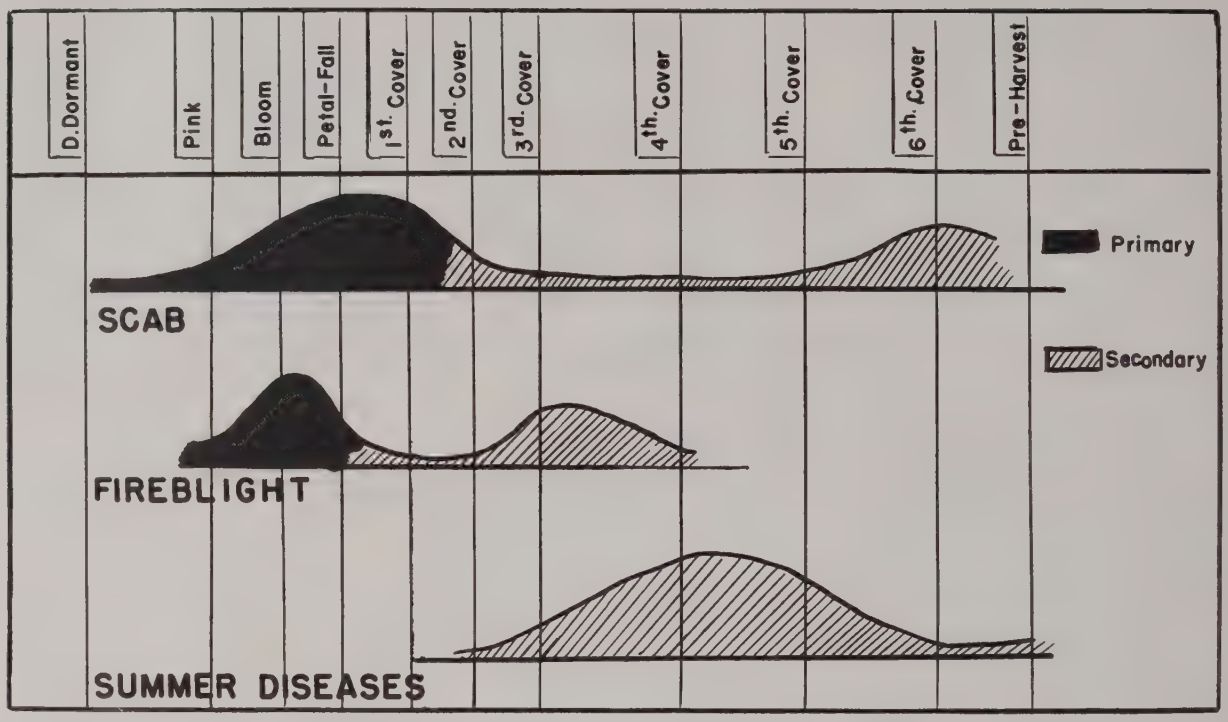
EFFECTIVENESS OF FUNGICIDES ON APPLE DISEASES

Table 14. Effectiveness of fungicides against apple diseases.

Fungicide	Bitter rot	Black rot	Blotch	Bot rot	Cedar rust	Fire-blight	Flyspeck & sooty blotch	Powdery mildew	Quince rust	Scab
Bordeaux mixture	E	G	G	M	P	G	E	M	P	G
Captan	E	M	M	M	NG	NG	G	NG	NG	E
Copper (fixed)	E	G	G	M	P	G	G	G	P	M
Dichlone	NG	NG	NG	NG	NG	NG	G	NG	NG	G
Dodine	NG	NG	O	NG	M	NG	E	NG	M	E
Ferbam	G	M	E	O	E	NG	E	NG	E	G
Folpet	E	O	O	E	O	O	E	NG	O	E
Glyodin	M	M	O	O	NG	NG	E	NG	NG	E
Karathane	O	O	O	O	O	O	O	E	O	NG
Niacide	G	O	E	O	E	NG	G	NG	E	E
Organic mercuries	O	O	E	O	G	NG	O	NG	G	E
Streptomycin	NG	NG	NG	NG	NG	E	NG	NG	NG	NG
Sulfur	NG	NG	NG	NG	NG	NG	G	E	NG	G
Thiram	O	O	G	NG	E	NG	G	NG	E	G
Zineb	M	M	E	M	E	P	E	NG	E	G

O—not recommended or no information, E—excellent, G—good, M—moderate, P—poor, NG—not good

ACTIVITY OF COMMON APPLE DISEASES



EFFECTIVENESS OF INSECTICIDES ON APPLE INSECTS

Table 15. Effectiveness of insecticides against apple insects.

Insecticide	Codling moth	R.B. leaf roller	Oriental fruit moth	E. red mite	2-spotted mite	Apple maggot	Scale crawlers	Plum curculio	Rosy aphid	Green aphid
BHC	NG	NG	NG	NG	NG	NG	NG	P	G	G
DDT	M	NG	G	NG	NG	M	NG	NG	NG	NG
Demeton	NG	NG	NG	M	P	NG	NG	NG	G	G
Dieldrin	NG	NG	NG	NG	NG	NG	NG	G	NG	NG
DNOC	NG	NG	NG	NG	NG	NG	NG	NG	M	G
DNOSBP	NG	NG	NG	M	NG	NG	NG	NG	G	G
Dormant Oil	NG	P	NG	G	NG	NG	M	NG	P	P
Endrin	NG	G	NG	NG	NG	NG	NG	G	M	M
Guthion	G	G	G	G	M	G	G	G	M	M
Kelthane	NG	NG	NG	G	G	NG	NG	NG	NG	NG
Lead Arsenate	P	P	NG	NG	NG	G	NG	G	NG	NG
Malathion	M	M	M	P	P	P	G	P	M	M
Methoxychlor	M	NG	M	NG	NG	M	NG	M	NG	NG
Mitox	NG	NG	NG	G	NG	NG	NG	NG	NG	NG
Ovex	NG	NG	NG	M	P	NG	NG	NG	NG	NG
Parathion	G	M	G	P	P	M	G	G	M	M
Phosdrin	P	G	NG	P	P	NG	NG	NG	G	G
Sevin	G	G	G	NG	NG	M	G	M	P	P
TDE	P	G	NG	NG	NG	P	NG	NG	NG	NG
Tedion	NG	NG	NG	G	M	NG	NG	NG	NG	NG
TEPP	NG	NG	NG	G	G	NG	NG	NG	M	M
Trithion	M	P	P	G	G	---	NG	NG	M	M

G—good, M—moderate, P—poor, NG—not good

Peach Production Problems

This section deals primarily with the special problem of borer control in peach trees. The fungicides and insecticides used against the insect and disease pests common to peaches are also rated for effectiveness.

BORER CONTROL IN PEACH TREES

The peach tree borer and the lesser peach tree borer often cause serious injury or death to peach trees. Both borers are prevalent in Indiana.

Peach tree borer is primarily a pest of young trees. It attacks and works beneath the bark of the trunk near the soil surface. Its presence is indicated by gummy masses containing sawdust-like bits of bark. The borers overwinter as larvae in burrows beneath the bark. They are about ½ inch long and are white with brown heads. The adults are clear-winged, blue and orange moths, which emerge around July 1.

The lesser peach tree borer is similar in appearance and causes much the same damage as the peach tree borer. These borers live beneath the bark of the trunk and scaffold branches. They are primarily a pest of older trees, especially trees of low vigor and those containing pruning stubs, wounds, narrow crotches and older borer injury. Adults of the lesser borer emerge about 30 days earlier than peach tree borers—about June 1.

Shothole borers also attack peach trees but are generally found only on weak or dying trees. These beetles make numerous small holes in the bark about the size of pencil lead. Since these borers are generally controlled by the regular spray schedules, they are seldom a problem in well-cared-for orchards.

Control Measures

Parathion, guthion and thiodan are recommended for controlling both the peach tree borer and lesser peach tree borer. DDT will control the former, but is not effective for the lesser borer. By using parathion or guthion in the regular spray schedule for other insects, you should also have satisfactory borer control if you pay special attention to spraying the trunk and scaffold branches with each application. Similarly, if you are using DDT for the peach tree borer, you will still have to make special applications of parathion, guthion, thiodan or dieldrin to the trunks and scaffold branches for lesser borer control.

If the regular spray schedule fails to control borers, apply special sprays to the trunk and scaffold branches as indicated in Table 16. Apply enough to thoroughly wet the bark surface. This deposit of insecticide is maintained during the period eggs are being laid and should kill both the adult moths and newly-hatched larvae.

Table 16. Special trunk sprays for borer control.

To control	Material and amount per 100 gallons	Approximate spray dates	
		Southern Indiana	Northern Indiana
Peach tree borer and/or lesser peach tree borer (Make 4 applications to trunk and scaffold branches.)	Parathion 15% WP at 3 pounds OR Guthion 25% WP at 2 pounds	June 1, June 21, July 12 and August 2	June 10, June 30, July 21 and August 11
Peach tree borer only (Make at least 2 applications to trunk from soil surface to crotch area.)	DDT 50% WP at 6 pounds OR Thiodan 50% WP at 1½ pounds[a]	July 5 and July 25 August 15[b]	July 15 and August 5 August 25[b]
Peach tree borer only (Make 1 application to trunk up to crotch area.)	Dieldrin 50% WP at 6 pounds	July 5	July 15
Lesser peach tree borer only (Make 1 application to trunk and scaffold branches as spot treatment.)	Dieldrin 50% WP at 6 pounds	June 1	June 10

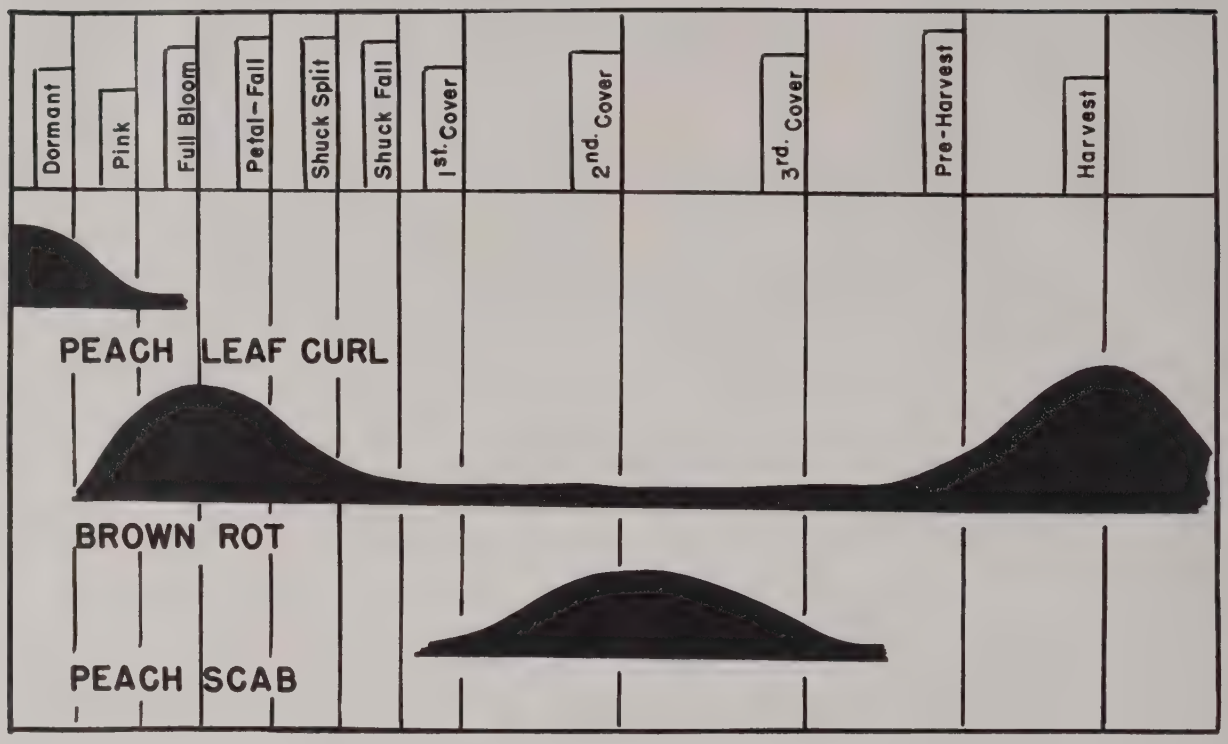
[a] Do not make more than 2 applications of thiodan during the fruiting period.

[b] A third application of DDT could be made and is recommmended on non-bearing trees, or on bearing trees as soon as fruit is picked.

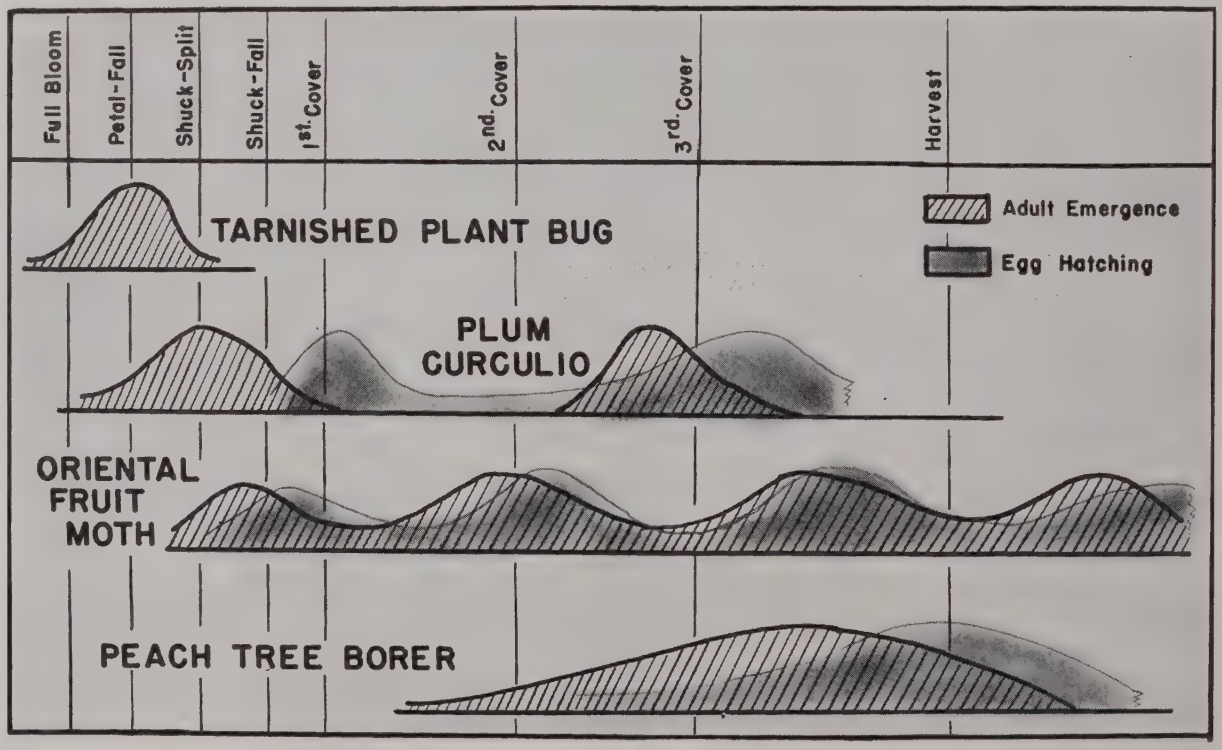
Special note: If the above sprays are applied to bearing trees, take care to avoid spray residues on the fruit, for the following harvest restrictions **must** be met:

Do not apply DDT, dieldrin or thiodan within 30 days of harvest; guthion within 21 days of harvest; or parathion within 14 days of harvest. Dieldrin may be used for spot treatment if fruit is not contaminated.

ACTIVITY OF COMMON PEACH DISEASES



ACTIVITY OF COMMON PEACH INSECTS



EFFECTIVENESS OF FUNGICIDES AND INSECTICIDES ON PEACH PESTS

Table 17. Effectiveness of fungicides against peach diseases.

Fungicide	Brown rot	Scab	Leaf curl	Bacterial spot	Powery mildew	Rust
Bordeaux mixture	O	O	E	P	O	O
Captan	E	G	E	P	NG	NG
Dichlone	E	G	E	NG	NG	NG
Dodine	M	G	O	P	NG	NG
Ferbam	M	M	G	NG	NG	E
Karathane	NG	O	O	O	E	O
Niacide	G	M	E	NG	NG	E
Organic mercury	O	O	E	NG	O	O
Sulfur	G	E	E	NG	E	NG
Thiram	G	M	O	NG	NG	O
Zinc Bordeaux	NG	O	NG	M	O	O
Zineb	M	O	O	NG	O	O

O—not recommended or no information, E—excellent, G—good, M—moderate, P—poor, NG—not good

Table 18. Effectiveness of insecticides against peach insects.

Insecticide	Stink bug	Tarnished plant bug	Scale crawler	Lecanium scale	Peach tree borer	Lesser P. tree borer	Oriental fruit moth	E. red mite	2-spotted mite	Leaf roller (flav.)	Curculio
DDT	NG	G	NG	NG	G	P	G	NG	NG	NG	NG
Demeton	NG	NG	NG	NG	NG	NG	NG	M	P	NG	NG
Dieldrin	G	G	NG	NG	G	G	NG	NG	NG	NG	G
Dormant Oil	NG	NG	G	G	NG	NG	NG	G	NG	NG	NG
Guthion	G	G	G	G	G	G	G	G	M	G	G
Kelthane	NG	NG	NG	NG	NG	NG	NG	G	G	NG	NG
Malathion	P	P	G	G	NG	M	M	M	M	M	M
Methoxychlor	P	M	NG	NG	NG	NG	NG	NG	NG	NG	M
Mitox	NG	NG	NG	NG	NG	NG	NG	G	G	NG	NG
Ovex	NG	NG	NG	NG	NG	NG	NG	G	P	NG	NG
Parathion	G	G	G	G	G	G	G	P	P	G	G
Sevin	G	G	G	---	P	P	G	NG	NG	G	M
TDE	NG	NG	NG	NG	NG	NG	NG	NG	NG	G	NG
Tedion	NG	NG	NG	NG	NG	NG	NG	G	G	NG	NG
TEPP	NG	NG	NG	NG	NG	NG	NG	G	G	NG	NG
Trithion	NG	NG	NG	NG	NG	NG	NG	G	G	NG	NG

G—good, M—moderate, P—poor, NG—not good

Strawberry Production Problems

This section is focused upon plant selection and general spray application recommendations as well as the special control problems that affect profitable strawberry production.

PLANT SELECTION

Use of new virus-free strawberry plants is strongly recommended for all new plantings in Indiana. Buy plants from reliable nurseries. This will help you avoid many insect and disease problems that would otherwise be encountered with plants from an old bed or other local sources. (For more information about virus-free strawberry plants, see Purdue Extension Mimeo HO-55-1.)

SPECIAL CONTROL PROBLEMS

Grubs and Soil Insects

White grubs, root aphids and other soil pests may seriously damage strawberry roots, especially where plants are set on newly-turned sod land. Treat all land that may be infested with white grubs or other pests with chlordane at 10 pounds actual per acre OR aldrin at 5 pounds actual per acre OR dieldrin at 5 pounds actual per acre. Apply before the plants are set, and work into the top 4 to 6 inches of the soil by light disking or harrowing.

Root Rots

Root rots and winter injury are the two most common plant killers in established strawberry plantings. The common root-rot disease attacks roots early in the spring, resulting in death of the plants at harvest time. Root-rot damage may

be greatly reduced by setting plants on well-drained sandy sites, by mulching to prevent winter injury and by applying adequate fertilizer to maintain plant vigor. In severe cases, use a soil treatment of zineb. (For further details of soil treatments, see Purdue Extension Mimeo BP-4-4.)

Nematodes

Nematode attack on strawberries often results in reduced yields and poor plant vigor. Control nematodes by treating the soil with fumigants. Since the presence of nematodes is difficult to determine by plant examination alone, it is wise to send soil samples containing roots to a nematologist for positive determination. Place samples in a plastic food freezer bag, and send to the Department of Botany and Plant Pathology at Purdue University.

SPRAY APPLICATION METHODS

All spray applications should be applied at high pressure (minimum of 100 pounds), using about 250 to 300 gallons of spray per acre. Pay special attention to thorough wetting of the plants and penetration of the mulch.

Dust treatments at the rate of 40 pounds per acre can be substituted for sprays in the regular spray schedule. If using dust formulations of any *one* of the following, the minimum amount of active ingredients should be—1 percent parathion; 4 percent DDT, chlordane and malathion; 5 percent thiram; and 7.5 percent captan.

Small acreage growers should seriously consider using power-driven back-pack equipment.

Trade Names of Agricultural Chemicals

Table 19 lists the common fungicides, insecticides, herbicides and growth regulators for fruit insect, disease and weed control. The chemical manufacturers and/or formulators, who furnished information for compiling this list, are coded in the last column and are listed at the end of the table.

WP—wettable powder, L—liquid, EC—emulsifiable concentrate, D—Dust

Table 19. Trade names and manufacturers.

Registered name	Trade name	Company
Fungicides		
Capryl	WP—Karathane WD EC—Karathane LC	11, 13
Captan	WP—Orthocide 50 W, Captan 50 W, etc. D—Orthocide 7.5 Dust, Captan 7.5	4, 11, 12, 14, 15
Dichlone	WP—Phygon XL, Phygon D—Plygon	1, 11, 12, 15, 17
Dodine	WP—Cyprex, Cyprex 65 W D—Cyprex Dodine	1, 3, 11, 12, 14, 15
Ferbam	WP—Ferbam 76 Fungicide, Ferbam W-76, Fermate, Carbamate, Ferbam 76 W, etc. D—Ferbam 87.5 Dust Concentrate, Carbamate Dust	1, 4, 7, 9, 11, 12, 14, 15
Folpet	WP—Phaltan 50 W	4, 11, 12, 14, 15
Copper	WP—Copper 53 Fungicide, Copper A Compound, Copper Sulfate, Basic Copper Sulfate, "340" Spray Cop, 530 Spray Cop, Copper Hydro Bordo, Instant Copper Sulfate, COCS, Copper Compound D—COCS Dust, Basic Copper Fungicide, Copper Sulfate, COCS, etc.	1, 4, 7, 9, 11, 12, 15
Glyodin	WP—Crag L—Glyodin	12, 16
Lime-sulfur	L—Lime Sulfur, Lime Sulfur Solution, Liquid Lime Sulfur	2, 4, 11, 12, 15
Maneb	WP—Manzate, Dithane M22	9, 11, 13, 15
Mercury	WP—Phix, Merbam-10, Dry Mercury Fungicide EC—Ortho LM, Puratized, Mercury Spray Liquid, TAG	1, 4, 6, 7, 11, 12, 15
Niacide	Niacide M	12
Sulfur	WP—Micro Flotox Wettable Sulfur, Sulforon, Wettable Sulfur, Dry Wettable Sulfur, Spraying Sulfur, Micro Dritomic Sulfur, Regular Dritomic Sulfur, Mag 70 Paste, Mag 75, etc., Kolospray, Kolofog D—Wettable Sulfur, Kolodust, Electric Dusting Sulfur, Owl Dusting Sulfur, Perfection Dusting Sulfur, etc.	1, 4, 7, 9, 11, 12, 14, 15
Thiram	WP—Thylate, Thiram 65 WP	9, 11, 12, 15
Zineb	WP—Zineb 65 W, Zineb 70 W, Parzate, Zineb Dithane Z-78, Zineb 75 W, Zineb Wettable Powder D—Zineb 85 Dust Concentrate	1, 4, 9, 11, 12, 13, 14, 15

Table 19. Trade names and manufacturers—Continued.

Registered name	Trade name	Company
Insecticides		
Aldrin	WP—Aldrin, Aldrin W-25, Aldrin 25 W, Aldrin 50 W	1, 4, 11, 12, 14, 15
	EC—Aldrin, Aldrin 2L, Aldrin 4 Emulsive, Aldrin 4 L, Aldrin 2 E, Aldrin 4 E, Aldrin EM-2, Aldrin EM-4, Aldrin 4 Miscible	1, 4, 7, 11, 12, 14, 15
BHC	WP—BHC 10 Wettable, Lindane W-25, BHC 12 Spray, 10% BHC, 12% BHC, BHC 12W, Benzahex W-12	
	EC—BHC 1 Emulsive, Lindane 16 L	
	D—12% BHC Dust	
Chlordane	WP—Chlordane 40 W, Chlordane W-40, Chlordane W-50, Chlorkil 40 Spray	4, 7, 11, 12, 14, 15
	EC—Chlordane 8 Emulsive, Chlordane 4L, Chlordane 8L, Chlorkil 72 Miscible, Chlordane 4 E, Chlordane 8 E	
	D—Chlordane 5% Dust, Chlordane 10% Dust, Coop Dust 14, Chlorkil 5 Dust	
Chlorbenside	WP—Mitox 40 W	4
	EC—Mitox 1.5 Emulsive	
Chlorobenzilate	WP—Chlorobenzilate 25 W	10, 12, 15
	EC—Chlorobenzilate 25 E	
DDT	WP—DDT 50 W, DDT W-50, Deenate 50 W DDT, Niatox 50, DDT 75, Genitox S-50, Genitox S-75	
	EC—DDT 2 Emulsive, DDT 2L, Niatox 25 Miscible, DDT EM-2, DDT 2 E, DDT 3 E	1, 4, 7, 9, 11, 12, 14, 15
	D—DDT 5% Dust, DDT 10% Dust, Coop Dust 11, Coop Dust No. 9, Niatox, 50 Dust Base	
Demeton	EC—Systox 2#/gal EC, Systox	5, 7, 11, 12
Diazinon	WP—Diazinon 25 W	10, 11, 12, 15
	EC—Diazinon AG 250	
Dieldrin	WP—Dieldrin 50 Wettable, Dieldrin W-50, Dieldrin W-75, Dieldrin, 50% Dieldrin WP, Dieldrin 50 WP	1, 4, 7, 11, 12, 14, 15
	EC—Dieldrin 1,5 Emulsive, Dieldrin 15 L, Dieldrin, Dieldrin EM 1.5	
Dimethoate	EC—Cygon	3
Dormant Oil	EC—Volck 70 Supreme Oil Spray, Superior Miscible Spray Oil, Ethion Miscible, Miscible Oil	4, 11, 12, 15
Endrin	WP—Endrin 75 Micro Wettable, Endrin 75-W, Endrin, 75% Endrin WP	1, 4, 7, 12, 14, 15
	EC—Endrin 1.6 Emulsive, Endrin 16 L, Endrin Miscible, Endrin EM 1.6, Endrin 1.6 E	
	D—Endrin 1% Dust, Endrin 2 Dust, Endrin 50 Dust Base	
Elgetol	WP—Elgetol	11, 12
	EC—Elgetol	
Elgetol 318	WP—Elgetol	12
	EC—Elgetol 318	
Ethion	WP—Ethion, Ethion 25% WP	1, 12, 14
	EC—Ethion 4 Emulsive, Ethion EM-4, Ethion Miscible	
Genite	WP—Genite 923 WP, 50% Genite "923"	1, 11, 12
	EC—50% Genite EM Concentrate, Genite "923" EM, Genite 923 E	
Guthion	WP—Guthion 25 WP, Guthion W	5, 11, 12
	D—Guthion 3% Dust	
Kelthane	WP—Kelthane W	11, 13, 15
	EC—Kelthane EC	
Lead Arsenate	WP—Standard Lead Arsenate, Hi-Test Lead Arsenate, Nu Rexform Standard Lead Arsenate, Suspenso Lead, Lead Arsenate	1, 4, 7, 8, 9, 11, 12, 14, 15
	D—Standard Lead Arsenate 10% Dust	
Malathion	WP—Malathion 25 Wettable, Malathion W-25, Malathion 25 WP, 25% Malathion WP	1, 4, 7, 11, 12, 14, 15
	EC—Malathion 8 Flow Concentrate, Malathion 5 L, Malathion 50% Liquid, Malathion 8 L, Malathion 5 Miscible, Malathion 5 E, Malathion 8 E, 50% Malathion EM, Aqua Malathion 8	
	D—Malathion 4% Dust, Malathion 5% Dust, Coop Dust 26, Malathion 25% Dust Base	
Methoxychlor	WP—Marlate 50, Methoxychlor "50," Methoxcide 50, Methoxychlor 50% WP	1, 8, 11, 12, 15
	EC—Methoxychlor 25 E, Methoxychlor EM-2	
Morocide	WP—Morocide 50 WP	12
	D—Morocide 4 Dust	
Ovex	WP—Niagaratran 50 WP, Ovex 50 W, 50% Ovex WP, Orthotran 50 Wettable, Ovatran	4, 11, 12, 14
Parathion	WP—Parathion 15 Wettable, Parathion 15 SP, Parathion 25 SP, Phoskil Spray, 15% Parathion WP, 25% Parathion WP, Parathion 400 Flowable	1, 4, 7, 11, 12, 14, 15
	EC—Parathion 8 Flow Concentrate, Parathion 2L, Parathion 4 L, Parathion EM-2, Parathion EM-9, Parathion 2E, 4E, 8E, Flowable Parathion 8L, Phoskil Miscible, Aqua Phoskil 6, Aqua Parathion 8	
	D—Parathion 1% Dust, Parathion 2% Dust, Parathion 5% Dust, Phoskil, Parathion 25% Dust Base	
Phosdrin	WP—Phosdrin 2, Phosdrin	1, 4, 11, 12, 14, 15
	EC—Phosdrin 2 Emulsive, Phosdrin 2L, Phosdrin 4 L, Phosdrin 4 E, Phosdrin EM-2, Phosdrin 2 E, Phosdrin 4 E	

Table 19. Trade names and manufacturers—Continued.

Registered name	Trade name	Company
Phosphamidon	EC—Phosphamidon 4 Spray	4, 12
Rotenone	D—Rotenone 5% Spray Powder, Rokil Spray, Coop Dust No. 4, 6	6, 10, 12
Sevin	WP—Sevin 50 Wettable, Sevin 50, Sevin 4 Flowable, Sevin 85 WP	11, 12, 14, 16
TDE	WP—TDE 50 Wettable, DDD 50 W, Rothane WP 50, 50% TDE EC—DDD Miscible, TDE EM-2, TDE 2 E D—DDD	1, 4
Tedion	WP—Tedion 25 Wettable, Tedion 25 WP, 25% Tedion WP, Tedion 90 W EC—Miscible 10, Tedion 1E	1, 4, 12
TEPP	WP—TEPP EC—Vapatone Emulsive, TEPP 40E, 40% TEPP	1, 4, 12, 14
Thiodan	WP—Thiodan 50 WP, Thiodan 50 Wettable EC—Thiodan 2 Emulsive, Thiodan Miscible	4, 11, 12
Trithion	WP—Trithion 25 WP, Trithion 4.0 Miscible, Trithion 400 Flowable EC—Trithion 4 E, Trithion 4 E Flowable D—Trithion 1,2,3,4% Dust	11, 12, 14
Herbicides		
Amitrole	WP—Amino triazole EC—Amitrol-T, Cytrol	3, 11, 12, 14, 15
Ammate	WP—Ammate X	9, 11
CIPC	EC—CIPC	11
Dacthal	WP—Dacthal 75 W	7, 11
Dalapon	WP—Dowpon	11, 12
Diuron	WP—Karmex	8, 11
DNBP	EC—Premerge, Dow General Weed Killer, Sinox	8, 11, 12, 15
Potassium Cyanate	WP—AERO Cyanate	3
Sesone	WP—Sesone, Crag Herbicide 1	11, 12, 16
Simazine	WP—Simazine 80W	10, 11, 12
2,4 D	EC—2,4-D Amine No. 2; 2,4-D Amine No. 4; Coop Amine, Coop Low Volatile Ester; Amsol (2,4-D Amine #4); Lo-Esta Sol (2,4-D LV Ester 4L); 2,4-D Amine 4 lb.; 2,4-D Amine 6 lb., Esteron 88, Esteron 44	1, 4, 7, 8, 11, 12, 15
Growth regulators		
NAA	WP—Fruitone-N, Sta Fast, Niagara-Stik, Stafast Spray Powder EC—Kling Tite 256 Emulsive	1, 2, 4, 11, 12
NA Amid	WP—Amid Thin-W	2, 11
NPA	EC—Peach Thin 322, Nip-A-Thin 602, Nip-A-Thin	2, 6, 11, 12, 17
2,4,5-TP	EC—Fruitone-T, Color Set, Stikcol, Stikcol-D (double strength), Staset Liquid	1, 2, 8, 11, 12
Wetting agents	EC—Ortho X-77 Spreader, Chipman Additive, DuPont Spreader-Sticker, Plyac, Triton B 156, Filmfast, X-77, Ortho Spreader-Sticker	1, 4, 7, 8, 11, 12, 13, 15
Scald inhibitors		
DPA	WP—83% Diphenylamine, No Scald DPA	1, 6
Ethoxyquin	Stop Scald	12

1. Allied Chemical Corporation, General Chemical Division, Kalamazoo, Michigan ("Orchard Brand")
2. Amchem Products, Inc., Ambler, Pennsylvania
3. American Cyanamid Company
4. California Chemical Company, Toledo, Ohio ("Ortho")
5. Chemagro Corporation, Kansas City, Missouri
6. Chemley Products Company, Chicago, Illinois
7. Chipman Chemical Company, Inc., Bound Brook, New Jersey
8. Dow Chemical Company, Midland, Michigan
9. E. I. duPont de Nemours & Co., Wilmington, Delaware
10. Geigy Agricultural Chemicals, Yonkers, New York
11. Indiana Farm Bureau Cooperative Association, Inc., Indianapolis, Indiana
12. Niagara Chemical Division, Wyoming, Illinois
13. Rohn & Haas Company, Philadelphia, Pennsylvania
14. Stauffer Chemical Company, Omaha, Nebraska
15. Swift & Company, Hammond, Indiana ("Gold Bear")
16. Union Carbide Chemicals Company, New York, New York
17. U. S. Rubber Company, Naugatuck Chemical Division, Chicago, Illinois

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